THE ADAPTATION OF THE VESSELS OF THE WESTERN GUNBOAT FLOTILLA TO THE CIRCUMSTANCES OF RIVERINE WARFARE DURING THE AMERICAN CIVIL WAR

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NICHOLAS F. BUDD, LCDR, USN
B.S., University of Illinois, Urbana-Champaign, Illinois, 1983
M.S., Naval Postgraduate School, Monterey, California, 1990

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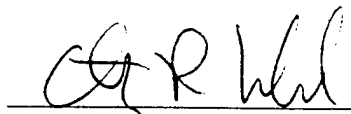

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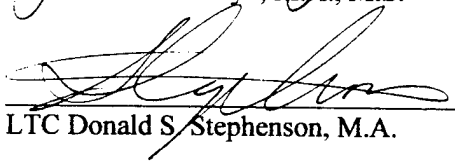

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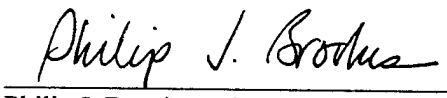

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ABSTRACT

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CHAPTER 1

HISTORICAL CONTEXT

Nations and their populations suffer tremendous human cost during wartime. In order to minimize this cost military organizations, more than any other group, must be prepared to adapt and seize the initiative when special conditions of warfare are presented on the battlefield. Throughout history these special conditions have taken many forms, usually in the guise of unique geography or innovative technology or tactics. An organization which adapts quickly to a developing environment, changing strategy, tactics, personnel training, and equipment and fitting itself to circumstances presented, has a tremendous advantage during a military campaign. This thesis will explore how one such military organization, the United States Navy, reacted to the necessity to conduct riverine warfare during the American Civil War. It will focus on the riverine fleet the Federal Navy created to wage war on American western waters, how this fleet came into being, the circumstances that shaped the evolution of its war vessels, and the technology employed during the process of evolution. In the process this thesis will explore the question of how successful the Western Gunboat Flotilla, later renamed the Mississippi Squadron, was at adapting its vessels to the operational environment presented by combat on waters of the Mississippi River drainage basin.

On November 6, 1860, Abraham Lincoln was elected president of the United States. By the end of January of the following year, this event and irreconcilable differences over states rights and the institution of slavery resulted in secession from the Union by seven states of America's deep South. Four other states would eventually follow suit and secede. In a desperate attempt to

avert an armed conflict between states loyal to the Federal Government in the North and the emerging Confederacy in the South, incumbent president James Buchanan made numerous concessions over military installations, arsenals, and equipment.[1] Unfortunately for the Union, the principle of loyalty to state before nation extended to the highest echelons of the Buchanan administration (including Secretary of War John B. Floyd). Southern politicians used their influence to shape the forces soon to be arrayed on Civil War battlefields. The cause of these men was aided by wealthy Northern merchants who were anxious to avoid war and its associated bad business at all ethical and moral cost. The disposition of American military assets was at the mercy of the loyalties of the personnel charged with their care. As a result, on the eve of the American Civil War, only two United States military installations in the deep South would remain under Federal control. Before a shot was fired, the Southern states seized war materials valued at over 30 million dollars and virtually all Federal defense facilities in the South fell into the hands of the Confederacy.[2] With the exception of Navy bases at Norfolk, Virginia, and Pensacola, Florida, the Federal Navy escaped the brunt of this seizure of material.

The officers of the United States Navy displayed a proportionally greater loyalty to the Union than their Army compatriots; perhaps because of a sailor's looser ties to the land. Whatever the reason, no United States Navy warship fell to the Confederates in the period prior to the attack on Fort Sumter. Unfortunately for the Union cause, the fact that it started the war with its Navy relatively intact did not prove to be as great an advantage as it could have been; at least not at the beginning of the conflict. The status of the fleet and the construction philosophy of the service very much reflected a peacetime force.

"After centuries of incremental progress in warship design, the Industrial Revolution and its consequences suddenly inundated the navies of the nineteenth-century world with cataclysmic and fundamental changes in naval warfare and vessels."[3] This quote strikes to the heart of the

worldwide state of flux in which warship design and construction methodology could be found as America began to wage civil war. While the Industrial Revolution began (in England) around 1760, at the onset of this war, many of the military by-products of the era were only just beginning to be incorporated into mainstream ship construction. Steam propulsion was common but not universal. The use of the screw propeller was in its infancy. Iron-hulled vessels were almost nonexistant and iron armored ships were still a novelty. The invention of the shell firing cannon and explosive projectiles had already signaled the end of wooden hulled warships, but worldwide, these weapons did not yet dominate the armament of the naval vessels of the time.

At the beginning of the war, the Federal Navy possessed only about ninety wooden ships, of which only forty-two were in commission. Of the ninety ships in the United States Navy inventory thirty-four were powered by sail alone. Service doctrine was dictated by an aging officer corps. Promotions within its ranks was strictly a matter of seniority. This method of promoting officers fostered its share of superannuated thinking and lack of initiative. Fortunately, there remained a few highly intelligent and capable officers who had shaped the technology and design philosophies within the service and kept the small fleet among the leaders in the world in employing emerging technology. As a result, twelve of the Navy's deep draft warships numbered among the finest vessels of their class in the world and were more than a match for any vessel the South could produce for a fight on the open ocean.[4]

The opening salvos on Fort Sumter found the United States Navy anything but ready for a fight in its home waters. When Lincoln finally took office on March 4, 1861, the Navy was largely deployed. Its Home Squadron consisted of only twelve vessels, of which only four were in Northern ports. Four additional vessels were stationed at Pensacola, Florida and the remainder of the squadron was in route from Vera Cruz, Mexico. When the war began, the United States Navy possessed no vessels specifically designed to wage war on America's rivers.[5] This is the

force that President Lincoln had at his disposal on April 19, 1861, when he declared the blockade of 3,549 miles of secessionist coastline, along an area which stretched from the Potomac to the Rio Grande rivers and encompassed 189 harbors, river mouths, and landfalls.[6]

At the time, a coastal blockade and ship-to-ship superiority on the open ocean were considered to be two minor facets of the Union strategy for the defeat of the South. A strategy called the Anaconda Policy was proposed by Army Chief of Staff Lieutenant General Winfield Scott. Its purpose was the strangulation of the South's ability to wage war. The Anaconda Policy called for the systematic severing of Confederate lines of communication and commerce by Federal land and sea forces. Once the South was isolated, the North would await its economic collapse and subsequent capitulation. This policy would require some time for its full effect to be felt. The adverse political ramifications presented by the spectre of a protracted war and a lack of overwhelming domestic support for a war effort in the North forced President Lincoln to reject this strategy as one which would not lead to a rapid solution to the problem of Southern secession. While rejecting Scott's plan as a strategy for conducting the war, Lincoln did take important points away from it in implementing his strategy for achieving victory against the South.

In addition to outlining a naval blockade of the Confederate coastline, Scott's plan called for a campaign to win control of the Mississippi River and the establishment of bases along the waterway from which to take the war to the South's heartland. In securing the Mississippi River and the tributaries of its drainage basin, the Union would secure an efficient means of deploying and supplying its forces in the field and deny the South the same. Controlling this vital waterway and its tributaries would effectively cut the South in two and allow the Union to "blockade" the entire "west coast" of the Confederacy.[7] By 1863, Lincoln realized the importance of this theater and made it the Union's main effort.

Establishing this river blockade presented a unique opportunity for the North. Unfortunately, it was one for which its small Navy was woefully ill-prepared to take advantage. Three things hindered the implementation of this strategy. First, the Federal Navy had no warships capable of effective operation on the inland waterways. Second, it had no personnel familiar with operating vessels of any sort on rivers. Finally, the Department of War controlled the inland waterways and were not particularly enthusiastic about relinquishing that control to the Navy.

Although its often stated objective was to open the Mississippi to Northern commerce along the river's entire length, the Navy never published a grand naval strategy to direct operations in the Western theater. There was, however, a strategic pattern in the conduct of the war on the Western waters. In early May 1861, Lincoln's Secretary of the Navy Gideon Welles received a letter from a prominent St. Louis riverman and businessman James B. Eads. The letter proposed the creation of a fleet of river war vessels to execute a blockade of the Mississippi River. Welles initially rejected Eads' proposal and referred him to the Department of War (Army). At the same time he ordered Commander John Rodgers to Cincinnati, Ohio, to assist in the creation of a "naval armament." While it served as the first step in the process of creating a naval riverine force, Welles' order to Rodgers clearly placed limits on Rodgers' authority.

> You will proceed to Cincinnati, Ohio, or the headquarters of General McClellan, where[ever] they may be and report to that officer in regard to the expediency of establishing a naval armament on the Mississippi and Ohio rivers, or either one of them, with a view of blockading or interdicting communication and interchanges with the States that are in insurrection.
>
> This interior nonintercourse is under the direction and regulation of the Army, and your movements will therefore be governed in a great degree by General McClellan, the officer in command, with whom you will put yourself in immediate communication. He will give such orders and requisitions as the case it him shall seem necessary, you acting in conjunction with and subordinate to him.
>
> Whatever naval armament and crew may be necessary to carry into effect the objects here indicated, you will call for by proper requisition.[8]

Someone in the Department of War had correctly reasoned that a naval officer would be useful in directing the arming of large river vessels with naval ordnance. To this end, Rodgers was ordered to serve as a naval advisor to the commander of the Army's Western theater. Welles also sent an experienced naval constructor, one Samuel M. Pook, to assist Rodgers in his task. Rodgers' subordinancy to McClellan, the Army's responsibility for the conduct of the war on the rivers, and the requirement to go through proper channels for the acquisition of men and materials were made very clear. Fortunately for the war effort, Rodgers was not the type of officer to concern himself with proper channels.

Upon his arrival, Rodgers undertook a program to purchase and modify for combat a squadron of three river vessels. He also contracted for the construction of nine ironclad warships, designed by Pook. These vessels later formed the nucleus of the Federal Western Gunboat Flotilla.

Rodgers' initiative in establishing a riverine force was not universally popular. When a confidant of the Secretary of War informed the secretary of Commander Rodgers' actions, a minor power struggle ensued at the highest levels of Lincoln's cabinet. As a result of debate between the Secretaries of the Navy and War, Welles wrote to Rodgers and forcefully reminded him of the limits he had placed on Rodgers authority, saying:

> It was distinctly stated in your instructions that that officer (General McClellan) would make the necessary requisitions. The movement in that quarter pertains to the Army and not the Navy. Nor must the two branches of service become complicated and embarrassed by separate action or any attempt at a combined movement on the rivers of the interior. You are, then, subordinate to the general in command, to aid, advise, and cooperate with him in crossing or navigating the rivers or in arming and equipping the boats required for the Army on the Western Waters. Should naval armaments be wanted for any of the boats, or crews to manage them, you were specifically authorized to make requisition for either or both, but nothing further. The Department can not recognize or sanction any contract for boats. They are not wanted for naval purposes.[9]

Welles' communication shows his lack of focus on both Navy and joint operations within the theater. Rodgers, in an apparent attempt to assure Welles that he was not overstepping what little

authority he had, answered this letter with a telegram stating, "General McClellan has approved the bills for the steamboats. The written approval of a superior officer makes an act of purchase his own."[10] Welles was evidently satisfied with Rodgers' reply. In an obvious effort to end interservice debate on the subject of responsibility for the conduct of the impending riverine war, he sent a message to the War Department saying that his Department was not "making arrangements for building or purchasing boats on the Mississippi River."[11] At the time, McClellan was in Virginia, involved in concocting a scheme to end the war by marching on Richmond. His involvement in the planning for what would eventually become the Penninsula campaign made him an ideal boss for a man like Rodgers; out of sight and mind. It is obvious that Rodgers, recognizing the requirement for a gunboat flotilla to support the Army on the interior waterways, took some liberty with the permission obtained from a distant McClellan.

Early on in the organization of the fledgling riverine flotilla, McClellan's authority was superseded by that of Major General John Fremont, the commander of the United States Army's forces west of the Mississippi River. A famous explorer, Fremont was more politican than strategist and his focus and motivation were probably not on his designated billet. Because of this, his assumption of command probably further exacerbated problems establishing responsibility for the construction of a Western waters flotilla. At any rate, in dealing with Fremont, Rodgers stepped on the wrong toes in his crusade to outfit a riverine force. Fremont himself sent word to President Lincoln asking that Rodgers be removed from any position of authority.[12] As a result, Rodgers was praised for his fine effort and then replaced by a more senior naval officer: Captain Andrew Hull Foote. In his final report as the embryonic flotilla's commander, Rodgers defended the methods he utilized in creating the organization, saying:

> This independent command has unfitted me for asking advice and help at every little impediment. Having been forced by years of necessity to act out the exigencies of the hour, I am now unable to feel the propriety of reporting little obstructions only to suggest means of overcoming them.[13]

Foote also experienced the unwieldiness of leading, supplying, and equipping a flotilla commanded by seafaring naval officers whose vessels were owned and under the operational control of the Army. Technically, he was attached to the Department of War. Unfortunately, as a naval officer, he was often tasked by Army officers who neither understood, nor cared about the conditions under which he operated. Because the Army of the West ranked him with lieutenant colonels, anyone senior to him could interfere with his operations. Since regiments were commanded by colonels, there were a lot of nonprofessional militia officers who outranked him. His organization was further hampered by the lack of an established shore base of operations and the periodic appropriation of personnel and supplies by the Army. As evidenced by the early correspondence of the Secretary of Navy, Foote received little assistance from either Welles or senior Navy leadership in relieving his problems of chain of command and supply. It was not until the success of the first campaigns on the Tennessee and Cumberland Rivers caught the eye of President Lincoln that Foote received some relief. Through the effort of Assistant Secretary of the Navy Gustavus Fox, Lincoln established direct communication with Foote, promoted him to flag officer (major general equivalent), saw to the establishment of naval facilities at Cairo and Mound City, Illinois, and ensured the provision of the equipment Foote urgently required. However, it was not until October 1862, after Foote's successor Flag Officer Charles H. Davis reached the Confederate stronghold at Vicksburg, Mississippi, that President Lincoln reorganized the Western forces and transferred the Western Gunboat Flotilla from the Department of War to the Navy.[14]

The use of considerable numbers of large warships, organized to fight on inland waterways, was a unique way of waging war in the military world of the 1860s. Conversely, the golden age of the commercial steamboat was reaching its zenith on the waters of the Mississippi River basin. The end result of this dichotomy was an industrial capability to create a riverine force which no one in the existing military establishment had any experience commanding.

Although the war ushered in the rise of the American rail system, prior to North-South hostilities the vast majority of interstate commerce traveled by the interior waterways where the steamboat was king. In his book, *Life on the Mississippi*, Mark Twain vividly describes the geography and conduct of river commerce on the Mississippi throughout its long history leading up to the Civil War. The Mississippi River and most of its fifty-four tributaries were uncharted until surveys were conducted by the Army Corps of Engineers in the late 1870s. These surveys were conducted to facilitate marine construction for channel management. Before these structures were created, the Mississippi was a winding river with a fast, treacherous current. It was full of bars, snags, shoals, and wrecks. Today, the navigable main channel of the river is marked with bouys to facilitate safe transit. In Twain's day it changed constantly with seasonal floods. The lack of proper charts and the ever-changing nature of the river itself made navigation for river pilots more art than exact science. Riverboat pilots memorized hazards to navigation and landmarks to aid in the location of the main channel for the entire length of the river upon which they were licensed to operate. Because the landmarks appeared different depending upon direction of travel, the memorization was accomplished for the trip both up and down river. This accomplishment was no mean feat. In the 1860s, the river wound for 1,218 miles between St. Louis and New Orleans; the channel being more than twice the straight line distance between the two cities.[15]

The knowledge essential to safely and efficiently navigate the Western waters was passed from pilots to youthful apprentices (cubs). The Mississippi River Pilot's Association regulated the number of pilots available for hire by limiting the number of apprentices trained and by controlling access to a written passdown maintained and securely stored at principal landing sites along the river. The passdown described current, hazards, best line or channel, and other information pertinant to river navigation. Continuously updated by Association pilots, it provided

a significant advantage for them in selecting the fastest and safest route up and down the river. After the first dozen or so riverboats piloted by non-Association pilots met with disaster due to a lack of skill or access to river lore, owners began to hire Association Pilots exclusively. Their pay and status were greater than that of a riverboat captain. In fact, the steamboat community had an aristocracy all its own. The pilots were the kings and without them travel on the Mississippi and its tributaries was exceptionally hazardous.[16] The ascendancy of the professional river pilot was the final step in the evolution of the inland waterway "merchant marine" of the steamboat era. The customs and hierarchy of this loose organization were the foundation upon which the Federal Navy would begin the organization of its riverine force.

The vessels of the Western Gunboat Flotilla were all commanded by seafaring naval officers. These officers were experts in the operation of deep draft, seagoing warships. Many captains served thirty years or more before attaining command. They were experienced in handling ships at sea and in the caring for, disciplining, and feeding their crews; however, the daily operation of a steamboat, warship or not, under the conditions described presented an entirely new set of circumstances for the majority of the professional naval officers of the Western Gunboat Flotilla. Initially, they were out of their element and would rely heavily on the expertise of experienced rivermen. Riverboatmen became junior officers on many of the vessels. Association pilots were much in demand and the early crews of the gunboats were an amalgam of landsmen, soldiers, rivermen, and Great Lakes and salt water sailors.[17]

When the South seceded from the Union, very little of the United States Navy went with it. Only about a fifth of the officers, no warships, and almost no sailors or equipment found their way into Confederate hands. Aside from the large naval facilities at Norfolk, Virginia, and Pensacola, Florida (which fell to the North early in the war), the South possessed very little in the way of a maritime infrastructure. As is often the case with undermanned, underfunded, and

outgunned military organizations, the Confederates relied on ingenuity, innovation, and boldness in the construction and employment of its small navy. As a result, it achieved some success during the conflict. Its contributions include innovation in ironclad ship design and its successes forced innovation and adaptation by the Federal Navy. Fortunately for the North, Southern preoccupation with a defensive posture along the rivers within its territory resulted in the construction of numerous shore fortifications and relative neglect in terms of the personnel and resources allotted to their interior navy.

Most Civil War historians agree that over the course of the war the western theater of Civil War operations became the Federal main effort. There is no doubt of the importance of the inland waters to Southern logistics and commerce. Prior to the war the Southern railroad network was underdeveloped relative to that in the North. In addition, Southern trains ran on tracks of four different gauges. Cotton was shipped primarily by tributary rivers to the Mississippi and then north to Northern mills or else south for shipment overseas to European markets through the port of New Orleans. Foodstuffs and manufactured goods traveled to Southern markets by the same routes. These same lines of communication became vital to the Confederacy when it came time to resupply its army in the field.

Never before in the history of the North American continent had war been conducted on so grand a scale. Resupplying armies over an inadequate road and rail network created a logistical nightmare for the rural, agrarian South. This nightmare made keeping the rivers open and available for the movement of supplies essential to the Confederate war effort.

Northern strategy dictated that the Union gain control of those same waterways. On July 4, 1863, in joint operations with Army Departments west of the Appalachian Mountains, the United States Navy split the Confederacy along a line defined by the Mississippi River. This

event, more than any other in that time frame, signaled the beginning of the end of the Confederacy.

This brief narrative establishes the historical and strategic perspective and motivation for the creation of the Western Gunboat Flotilla. The actual modifications to existing vessels and methods of construction of purpose-built river war vessels are as unique to the period and locale as the circumstances that shaped the organization. It is the description of these actions and the analysis of the evolution of techniques for construction and modification in the context of trial by fire that will form the basis for the conclusions in this thesis.

CHAPTER 2

INITIAL EFFORT

The Federal government conducted two distinct naval construction programs during the Civil War, one for coastal and open-ocean vessels and another for river vessels. The distinction was a result of the extreme divergence in the environment under which each type of vessel would operate. The principal factor in this divergence was the depth and geography of the rivers of the Civil War western theater of operations.

Conditions and Constraints

The western river campaign was fought on the rivers of the Mississippi River drainage basin. Today, in conjunction with river traffic and dredging, there exists a system of dams, wing dams, levees, and other marine constructions to control the river stage and current on the waterways of the basin. Major efforts to build these structures and control the channels of the rivers of the basin did not begin in earnest until the 1870s. As such, during the Civil War era, the depth of rivers varied greatly with seasonal rains and snow and ice melt. Seasonal floods and variations in river currents caused by them, resulted in regular shifts in the location of the channels of all the rivers in the basin. The muddy nature of the water prompted the buildup of the geologically distinct alluvial levees common to the Mississippi River. Shoals and bars formed at river bends and mouths of streams, and snags were created from debris washed into the rivers from river banks and tributary streams.

Rapids on the Cumberland, Tennessee, White, Red, and Arkansas rivers posed hazards to navigation even during high water. Low water made large portions of these rivers too shallow to

navigate during the dry season. Even the largest rivers were affected by seasonal variations, particularly in the vicinity of the rapids. During mid-winter and mid-to-late summer the Ohio River above Louisville, Kentucky, and the Mississippi upriver from St. Louis were hazardous due to low water.

As a result of periodic low stages on the rivers, naval constructors of the era were forced to build boats of exceptionally shallow draft. In the parlance of the era, vessels were built to navigate a heavy dew. It was not uncommon for a steamboat to draw as little as eighteen inches and rarely would one be found drawing more than five feet. The requirement for shallow draft resulted in very shallow depth of hold; indeed, even the largest of commercial steam boats measured only ten feet from keel to main deck.[1]

This convention forced the bulk of river cargo to be carried on a vessel's main deck. During the Civil War era the distance, as the Mississippi flowed, from Cairo to Head of the Passes was just under 1,100 miles. The straight line distance between the same points is 480 miles. There were places along the course of the Mississippi River where thirty miles of river flowed between points separated by two miles overland. Navigating the torturous path followed by the river demanded maneuverability in the vessels which plied its waters. The requirement for maneuverability alone limited the practical physical length of vessels trafficking the waters of the Mississippi basin.

Beginning in the 1820s, the Mississippi and her tributaries were the principal commercial highway for the transportation of large quantities of bulk goods and passenger traffic in the American West. Population centers were few and widely scattered. However, what population there was relied heavily on commercial river traffic for goods and service. Of necessity river vessels operated from unimproved port facilities. Often the facilities consisted of nothing more than an area on the bank of a river cleared of timber from which cargo and passengers could be

loaded and unloaded. Coal was not readily available and repair facilities were almost nonexistent between major population centers.

Because repair facilities were scarce, propulsion machinery installed in river steamers needed to be mechanically simple. In fact, riverboat machinery was primitive even by the standards of the day. Because screw propellers were easily fouled by snags and shoals, paddle wheel propulsion was employed almost exclusively. During the era, paddlewheel propulsion design followed two basic configurations: sidewheel and sternwheel.

Sidewheel propulsion offered the advantage of greater maneuverability. Port and starboard wheels were powered by dedicated engines and machinery, allowing independent control. By backing one wheel and going forward on the other, a vessel could theoretically be made to pivot about its axis. The ability to maneuver in this manner was essential when navigating narrow, twisting channels, made doubly hazardous by violent currents.

The use of sidewheel propulsion greatly facilitated double-ender construction. River ferries were almost exclusively double-enders. Since both ends were bows, this construction alleviated the need to maneuver a vessel in mid-channel to present its bow into a landing to offload and onload cargo. The construction technique offered great savings in time and mechanical effort, considering the effectiveness of the engines and strength of the river currents encountered on a cross -channel trip. Because their decks were already strengthened to carry the weight of loaded vehicles, ferries were relatively easy to modify to carry the weight of heavy naval ordnance.

The major disadvantage of sidewheel propulsion in military application was its vulnerability. The wheels were midships mounted outboard on both port and starboard sides of a vessel. On commercial packets they were covered, but hardly protected, by paddleboxes of light

and purely decorative construction. Any fires heavier than rifle fire striking these structures, the wheels, or their exposed machinery presented a real threat of disabling the vessel.

Sternwheel propulsion was used primarily in tugs and smaller packets. This design utilized one or two engines with associated machinery driving a common wheel. The advantages and disadvantages of this configuration were exactly opposite of those of sidewheel propulsion. Sternwheelers relied on conventional rudders for maneuvering. Rudder authority was limited by the lack of powerplant horsepower and by the absence of a directionally stabilizing deep keel in flatbottomed riverboat hulls. Maneuverability suffered in purportion to the lack of rudder authority.

In practical application the propulsion method chosen effected more of the physical layout of a vessel than that of its machinery spaces. The hull of a sternwheeler was different from that of a sidewheeler. The sternwheel generally rode in a raceway between two short sponsons which formed the aft end, or "fantail" of the hull. Militarily, this simplified the procedure for modifying the vessel to protect vital machinery in that it was already located in an interior, semi-protected position.

Riverboat powerplants utilized high pressure firetube boilers without forced draft. The plant provided steam for two cylinder, poppet valve engines. This was a design virtually unchanged since its introduction into naval construction in the 1810s. A typical 600 horsepower plant of the era consisted of a steam plant, auxillary machinery, and single expansion, condensing or non-condensing engines. Steam for the engines was generated in high pressure (150 pounds per square inch) firetube boilers. The typical size of the boilers utilized on commercial packets was about twenty-five feet long by thirty-six inches in diameter. Convention of the period dictated that given vessels of roughly similar dimensions, the performance of the plant was enhanced by the addition of more boilers rather than increasing to any great degree their physical size. The

boilers were mounted side by side on the main (boiler) deck of a riverboat and were fired by a common firebox fitted to the forward section of the boilers with cast iron fire fronts. Wood or coal was burned in the fire brick lined firebox providing the hot gases which were routed through boilers containing varying numbers of firetubes. These hot flue gases heated the water in the firetubes, converting it to stream. That steam was collected under pressure in a steam drum mounted perpendicular to and above the boilers. The steam drum was essentially a manifold which acted as a conduit collecting and routing steam to the engines and auxillary equipment. Feed water was pumped from the river by an auxiliary engine (also powered by steam from the plant). The final component of the system was a mud drum mounted perpendicular to and below the boilers. This device filtered system-clogging sediment from the river feed water and physically supported the boilers. A five boiler powerplant of the size described here would consume eighteen to twenty bushels (approximately 2,000 pounds) of coal per hour.

Since a typical steam plant did not have fan forced draft, the use of distinctive tall cylindrical stacks was essential in generating enough draft to create sufficient steam pressure to run the engines. Wood burns much cooler than coal. Steam pressure in the plant could be raised only by increasing the temperature of the fire. The only way to raise that temperature was to force more air into the firebox. This could be done in only two ways: use a fan or make use of the venturi principle and utilize a long narrow exhaust. Since period powerplant design ran to simplistic construction and a pipe has no moving parts, naval constructors of the era adopted the riverboat's characteristic tall stacks as their preferred method of drawing air through a boat's stream plant.

Because coal was relativally scarce and expensive, commercial steamboats of the era often used cut wood to generate steam. The timber was felled from stands along the watercourse. Logging operations were conducted to furnish wood for fuel and cut wood was stacked in piles

along river banks as a ready supply for steamers. An unfortunate by-product of the cutting operation was the rows of stumps which, when submerged by high water and shifting channels, offered the potential to rip the bottoms of riverboats.

Utilizing wood to fuel riverboat powerplants created an unexpected hazard for Union personnel. During the Civil War, the Confederate strategy for controlling the rivers was purely military. That is, their plan for control involved holding the banks by erecting fortifications which commanded the waterways in strategically important areas. Part of their plan involved clearing the immediate banks of the waterways of the basin of usable timber. Forced farther from the river banks to forage for fuel, Federal sailors often found themselves under fire from Confederate personnel without benefit of covering fire from their vessels.

For commercial steamers, the abundance of cheap fuel located on riverbanks alleviated the need for fuel economy in powerplant construction. Without an economic stimulus to create a demand for innovation, improvements in riverboat powerplant technology were stifled between the 1820s and the Civil War. It was a fact of riverboat operations that the numerous snags, bars and shoals on the rivers resulted in a lot of wrecks. The simplicity of steamboat powerplant design greatly enhanced its survivability during those calamities. According to experienced Mississippi and Illinois River rivermen, salvors made fortunes recovering cargo and machinery from sunken vessels.[2] Whatever their stimulous, the practice of riverboat constructors recycling salvaged powerplants into new hulls further hampered technological improvement

The speed of the current on the Mississippi and her tributaries varied greatly with season, stage (water level) and pilot-selected channel. The path a river pilot selected when navigating between two points varied depending on conditions on the river. He endeavored to choose the shortest path consistent with his vessel's draft, and to steam against the weakest current he could

find. Conversely, steaming downriver, he would take advantage of the current to increase his speed.

The best powerplants of the era propelled the fastest of the era's steamboats at sustained speeds approaching fifteen miles per hour. The fastest passage on official record between New Orleans and Cairo, Illinois, was three days and one hour, yielding an average speed of a little better than fourteen miles per hour. The vessel was the famous MV *Robert E. Lee* and the record was set on the occasion of a race between the *Lee* and the MV *Natchez*. Both vessels were lightened, optimally trimmed and were steamed with plants operating at pressures higher than considered normal for the sake of safety.[3]

River vessels operated under conditions where speed was essential for commercial success. For a fast river transit, owners relied more heavily on the vessel's pilot selecting an optimum route than on the muscle provided by its powerplant. Military vessels utilized these same powerplants fitted into hulls vastly heavier for their dimensions than their commercial counterparts. As a result the military vessels suffered from inferior speed and maneuverability.

Commercial steamboats were called "packets." Their characteristic barge-like, broad beamed, shallow draft hulls were a physical and economic compromise intended to allow commercial vessels to operate profitably under the conditions described. These hulls were unique to the steamboat era. Donald Canney, in his book *The Old Steam Navy*, describes the principal flaw in the design:

> With such shallow, wide and lengthy hulls, the major design problem was preventing hogging (the tendency of a hull to droop at the ends). These hulls were so limber and flexible that when a vessel was left high and dry after flood waters receded, the hull would drape itself to conform to the lay of the land; more amazingly, some of these vessels successfully regained their shape when refloated.[4]

To correct this tendency naval constructors installed "hog braces" and chains. The truss like system of vertical stanchions and rod braces ran longitudinally, supporting the bow and stern of a

vessel, preventing the hull from "working" (flexing). The flexing of the hull due to its broad, shallow dimensions damaged its structure; resulting in opened seams and leaks. It is interesting to note that while hog braces prolonged the life of the hull, they tended to slow the vessel. In the steamboat race between the *Natchez* and the *Robert E. Lee*, the *Lee* had her hog chains loosened. This allowed the hull to "ride easier" on the surface of the river, thereby increasing her speed and contributing to her ultimate victory.[5]

The peacetime proliferation of the steamboat on the Western waters was a result of their considerable commercial success. In turn, that success hinged upon the ability of steamboats to carry large cargos on each trip up and down the river. Building a boat with sufficient displacement to carry a large cargo under the conditions presented by the unique geography of the river system in the American west of the 1860s presented a challenge to naval constructors. Before the war, hull dimensions were dictated by the necessity for the vessels to be able to carry a large cargo of heavy (pressed cotton) bulk goods on each trip up and downriver. During the war, hull dimensions in purpose-built ironclads were dictated by the requirement to mount heavy naval ordnance and armor on hulls designed to draw between three and five feet of water. Modifying river steamers to gunboat configuration vastly increased their weight without appreciably increasing hull dimensions. The result was deeper draft and dramatically reduced freeboard in vessels which prior to modification had three to five feet between gunwale and waterline. One interesting benefit of the low freeboard was that the surrounding water provided additional protection against enemy fire for a vessel's lower hull.

Fortunately, the inherent simplicity of riverboat construction lessened the technical burden of increasing hull dimensions. This allowed constructors to obtain the necessary displacement to float armor and naval ordnance while maintaining the required shallow draft and, to a lesser

extent, sufficient hull rigidity to preserve watertight integrity. The degree to which that rigidity was maintained became a critical factor in the performance of riverine war vessels.

At the onset of the Civil War the most abundant vessels available for conversion were commercial steamers (packets). The typical packet was between 150 and 275 feet in length and carried 30 to 55 feet of beam. It drew from eighteen inches to six feet of water. Its hull floated tall superstructures, normally with three decks. The main or "boiler" deck carried bulk cargo and housed the boat's machinery. One deck up was the second or "hurricane" deck. This deck housed passenger cabins, saloons, barber shop, scullery and ship's officer's cabins. The next deck up was the "texas" deck which carried the pilot house ("texas"). The overall height of these vessels, from waterline to the tops of the spark arresters on their stacks, often topped 150 feet.

Construction above and below the waterline was very light. In his report to Secretary of the Navy, Gideon Welles, on the occasion of his relief, Commander John Rodgers characterized the nature of the vessels he found when he began building what would become the Western Gunboat Flotilla.

> I found in the west only river steamers, with their high pressure boilers on deck, with all their steam connections entirely exposed, and with three story houses of thin white-pine plank erected on their hulls: such were all the boats. The basis did not strike me favorably for conversion into war vessels; yet I considered that the Government wanted gunboats immediately; that it was my duty to use the materials; it was easy to make objections; I should rather use to the best advantage the means at hand.[6]

It is clear that Commander Rodgers believed that time was of the essence in getting a Federal flotilla afloat and in action before the Confederates had a chance to fortify the banks of the Mississippi and her tributaries. As a result, he vigorously pursued an agenda to create a riverine force for service on the waters of Mississippi basin.

Timberclads

In June 1861, on his own authority, Rodgers purchased three river steamers in Cincinnati, Ohio for conversion into gunboats. The vessels were the MV's *A.O. Tayler*,*Lexington*, and the *Conestoga*.[7] All three were sidewheel boats equipped with high pressure boilers. They had a combined displacement of 1167 tons. S. M. Pook, the naval constructor sent with Rodgers to assist in constructing and outfitting a flotilla apparently helped him choose these three vessels. Rodgers and Pook based their criteria for purchase upon the vessel's "above average soundness" and suitability for conversion. In his letter to Gideon Welles regarding their purchase, Rodgers alludes to the process required to modify river steamers for military use.

> All the river boats are so different from war vessels in all their appliances that considerable alterations are necessary to fit them for use. They need a good deal of strengthening, and because the crew would be liable to be picked off while passing along the banks of the river in places where no effectual return fire could be made to the fire of an individual, I decided upon putting bulwarks of oak plank 5 inches thick, which I found by experiment a sufficient guard against small arms.
>
> The boilers and engines can not be defended against cannon shot. We must take our chances.[8]

Apparently the process of determining the specification for the five inch oak thickness for the bulwarks involved shooting progressively thicker pieces of oak from a nominal range with a service musket until the wood could no longer be penetrated.

In his final report to Welles, dated September 7, 1861, Rodgers further describes the vessels and their conversion.

> These vessels were sound and above average strength. Timbers and beams were put in to strengthen them to bear their batteries; the thin board houses taken off and solid bulwarks of 5 inch oak plank put round them; the boilers were dropped into the hold and the steam pipes were lowered as far as possible.[9]

The armament for the three vessels, as originally ordered by Rodgers, was to total sixteen 32-pounder cannon. The 32-pounders described as part of the initial armament for these vessels weighed in at 5,700 pounds apiece. The standard naval four wheel carriage was most commonly

used to mounts cannon on the vessels of Western Gunboat Flotilla. Using this carriage on the smooth decks of warships, the recoil of discharged ordnance was absorbed by heavy hemp hawsers, attached via equally heavy tackle to the ship's bulwarks (hull). Similar, but lighter tackle was also attached to the guncarriage and bulwarks to aid in training the weapons and running them out their gunports prior to firing. The great weight of the ordnance required a substantial deck to stand up under the abuse of loading, aiming and firing in combat. The decks of the lightly constructed river steamers simply could not bear the loads without reinforcement.

Dropping the boilers into the holds of river steamers during conversion is a very logical modification. Historically, naval constructors have placed vital machinery and volatile munitions and fuel below the waterlines of warships to afford these critical and dangerous components additional protection against enemy fire. In the case of river steamers this practice is complicated by two factors: primitive boiler design and the characteristic shallow depth of hold of period vessels.

As already described, the steam drums on the powerplants of the era served as a steam collecting manifold for the plant's boilers. Attempts to lower the steam drums into a hold on the level of the boilers resulted in water collecting in the drums. In the worst case, "working water" could disable the engine and at the very least, greatly reduce its efficiency. Due to the shallow depth of hold, raising the steam drums to prevent the accumulation of water brought them above the waterline and out of the protective hold of the vessel. A later chapter will describe the disastrous result of this compromise.

Mounting a vessel's battery as high off the water as its construction would allow was critical given the geography of the riverbanks and the principal task given gunboats during this period; direct attack of shore based batteries and support of land forces ashore. Naval ordnance pieces of this period were primarily direct fire weapons intended to put fires on naval vessels at

sea. Discounting high seas, there are generally few obstacles between warships engaged in battle at sea. Experience and convention influenced period naval constructors. As such, in designing or modifying river steamers for military use, naval constructors often mounted their batteries in positions which precluded them from bearing on targets mounted high on embankments or even being able to lob shells over levees and berms. These obstacles dominated the terrain of the banks of the Mississippi River and her tributaries. In his article "Old Man River, 1863," Lieutenant Commander H. G. Dohrman describes the terrain Federal gunboat commanders faced.

> As is well known, the Mississippi through much of its length lies above the surface of the adjacent lands, whose rich plantations are protected against customary seasonal floods by dikes or levees.
>
> On the west bank of the river are but few locations in which the land lies much above the river level, indeed the only one of importance being Helena, Arkansas. On the east bank, however, there are several. From Columbus, Kentucky, about 21 miles below Cairo, to Baton Rouge, Louisiana, is a distance of some 600 miles by river, and along this high river frontage were located the important points of Port Hudson, Grand Gulf, and Vicksburg. Each of these points being on high and commanding ground, the Confederates promptly fortified them, as strongly as their resources permitted.[10]

Later text will describe purpose-built ironclad vessels which, because of how their batteries were mounted, could not bring their guns to bear on the enemy under certain circumstances of terrain. It is possible that mounting ordnance high above the waterline on the timberclads was a fortunate accident of war. A more likely explanation is that without heavy iron armor, the light vessels carried a greater freeboard and constructors were able to mount ordnance higher above the waterline without adversely affecting the vessel's stability and maneuverability.

One or more of the timberclads served in nearly every campaign on the Western waters. Apparently, their effectiveness was largely due to their heavy armament and its high mounting, particularly in the case of the gunboat USS *Taylor*.

> The Tyler [Taylor] was a large high pressure wooden steamer, entirely unarmored, her wheels unusually far back, and with two very tall smokestacks. In fitting her for the naval service she had been divested of all her upper or "hurricane deck" and "texas," thus giving her a flush spar deck three quarters of her length, with a spacious poop deck, raised some six feet, which afforded comfortable cabins for the commander.

> She mounted ten 8-inch guns of sixty-three hundredweight on the berth deck, a 30-pound Parrott rifle on the forecastle, and two brass 12-pounders on the poop. This was a very formidable battery for a river steamer: and as she was very high out of the water, when the river was at a good stage her guns commanded the low banks and could sweep the level country for a great distance.[11]

Aside from the advantagous manner in which their batteries were mounted, a timberclad's greatest single asset was its speed. While possessing neither radical hull design nor particularly powerful machinery relative to the other vessels in the Western Gunboat Flotilla, the timberclad's greater freeboard, lighter draft and lighter weight gave it a considerable speed advantage over their purpose-built sisters. This characteristic would make them ideal for escorting Army troop transports and Federal supply convoys.

Tinclads

Vessels of a similar class of river warships were commonly known as "tinclads." While they were the most numerous type of warship on the interior waters during the Civil War, they were apparently not modified to any certain specification, nor were any plans drawn up to direct construction or document the work done. In 1863, Rear Admiral David Dixon Porter described the addition of two inches of iron armor plating, backed by eight inches of oak, to the sides of "light drafts" to make them musketproof while still retaining their three foot draft. Another source described the addition of one-half to three-fourths of an inch of railroad iron covering "ordinary river steamers" to a height of eleven feet. The modification was intended to protect them against musketry and the fire of field artillery pieces. Porter also specifies a requirement for further protection of the boilers in order to ensure complete protection against fires from these weapons.[12]

Tinclads generally carried 6 to 8 guns and often carried as many as 200 troops when circumstances required. The troop-carrying capability alone made them extremely versatile. Except for the addition of iron armor, the modification of these vessels closely mirrored that of the three timberclads. Their contribution is summed up by Captain Rafael Semmes, CSA of CSS

Alabama fame. Semmes, in commenting on the vessels of the Western Gunboat Flotilla, said. "the enemy had converted every sort of a water craft into a ship of war, and now had them in such number that he was enabled to police the river in its entire length, without the necessity of his boats being out of sight of each others smoke."[13] Under pressure to float vessels to support Union troops ashore, marine yards throughout the North modified a large number of river steamers into vessels of this type.

The following is a summary of the common modifications made to river steamers in creating the timberclad and tinclad "classes" of riverine warship:

1. Boilers lowered into holds.
2. Superstructures cutdown to main ("boiler") deck.
3. Decks strengthened to bear weight of battery.
4. Bulwarks constructed to protect personnel, ordnance and vital machinery and to carry loads transferred by the gun tackle.
5. Pilot house protected by wood or wood backed iron armor.
6. Iron armor added as available or deemed necessary (tinclads).

Ellet Rams

Perhaps the most unusual of the Civil War riverine warships were the Ellet rams. Charles Ellet, Jr., envisioned creating a fleet of steam rams to attack Confederate war vessels on the Western rivers. Ellet was a civil engineer who was commissioned a colonel in the Army. An expert on marine construction (bridges, dams, locks), Ellet's fascination with rams dated from experience as an observer during the Crimean War. With the exception of a single campaign the rams did not play a major part in the war on the Western waters. Ellet's own description of the conversion of river steamers to a ram configuration follows:

> running three heavy solid timber bulkheads, from 12 to 15 inches thick fore and aft, from stem to stern, placing the central one directly over the keelson: in bracing these bulkheads one against the other, and the outer ones against the hull of the boat, and all against the deck and floor timbers, and staying the hull from side to side by iron rods and screw bolts: in fact, making the whole weight of the boat add its momentum to that of the central bulkhead at the moment of collision. In addition, the boilers and machinery are held by iron straps in all directions, the pilot house protected against musketry, and the engines and boilers shielded by 2 feet thickness of oak timbers, well bolted together.[14]

Since these vessels were originally intended to be pure rams (no guns) they lacked the armored casemate prevalent on the majority of riverine warships. The fore and aft timbers strengthened the hull along the longitudal axis of the vessel. Bracing these heavy timbers against each other and against the hull and deck timbers served to transfer the whole weight of the vessel to the center timber, preserve the integrity of the hull and effectively increase the force available for collision. It is interesting to note the iron stays which braced the vessel's machinery about its axis. This very heavy machinery was bolted onto the wooden boiler deck of the vessel. In its commercial configuration this machinery could not withstand the impact of a ramming without tearing loose from its bed. The heavy oak armor placed around the machinery evidently took the place of lowering the machinery into the vessel's hold.

The exact chain of command for Colonel Ellet and his ram fleet was a matter of some debate. The Department of War granted Ellet his commission and financed the ram fleet. Ellet's fleet was under the operational control of the Navy commander of the Western Gunboat Flotilla. That flotilla was controlled by the Department of War until October 1862. To confuse matters more, several of the major vessels in the ram fleet were commanded by Ellet family members and friends. This "command situation" resulted in a dearth of official records concerning modifications and the performance of Ellet's fleet in action.

USS *Essex*

The USS *Essex* was the end result of another riverboat conversion. This vessel was converted from a Mississippi River ferry boat, the MV *New Era*. The *New Era* was a recessed sternwheel double-end steamer. As already discussed, the great strength of sternwheelers in military conversion was in the ease of protecting the paddlewheel and vital machinery. In the case of the *New Era*, that wheel was initially driven by a relatively small powerplant. Her engine had small cylinders which, of course, limited their horsepower. There is some question of how many boilers she had when initially converted; accounts vary between three and four. At any rate, early photographs of the vessels show that her fireboxes were drawn by a single stack, suggesting a small or inefficient powerplant.

The vessel's recessed wheel and its associated machinery was located amidships. The small size of the superstructure relative to her 159 by 47 foot main deck facilitated the construction of characteristic timberclad bulwarks around its perimeter. The large, open deck area, already strengthened to carry cargo, was ideal for carrying a heavy naval battery. As initially modified, the *New Era* became the timberclad USS *Essex*. The bulwarks were 6½ feet high all around, approximately one-foot-thick fore and aft and pierced for nine guns. Interestingly, the casemate was only decked over abreast the original superstructure, leaving the heavy gun positions fore and aft exposed from overhead. Later chapters will discuss tactical employment of riverine vessels, but suffice it to say this deficiency was not in keeping with the Federal propensity for attacking targets bow on. The *Essex's* original armament included three 9-inch Dahlgren smoothbores.

After a single sortie up the Cumberland River this configuration was deemed unacceptable. Her second modification involved the addition of a light deck over the gundeck both fore and aft. The bulwarks were extended upwards to meet this new deck. Accounts vary,

but it appears as though iron armor plating was added to the forward face of the casemate. This plating probably did not extend all the way to the hurricane deck. In addition, it is probable that three-fourths inch iron plate was added to the sides of the entire casemate during this modification. The vessel would fight in this configuration until after the battle for Fort Henry.

USS *Benton*

Another of the early conversion ironclads was the USS *Benton*. This vessel was originally constructed as a snag boat. Among the earliest measures taken on the rivers of the Mississippi drainage basin to maintain a navigable channel was the employment of snag boats to remove bottom-ripping river snags from the waterways. Many of these vessels had catamaran hull designs which allowed pilots to maneuver a snag between the boat's sponsons where the crew would secure it to bits or capstan and either saw the offending wood off or pull it out of the bottom. Once secured to the vessel, the pilot used the combined power of the boat's engines, the current and the steam capstan engine to pull on a snag. The hazards of this work are obvious. A lack of attention could put a snag boat hard onto the very hazard it was trying remove. Because of the inherent risk, vessels of this type were generally of particularly sturdy construction.

James Eads converted one of these vessels, *Submarine Boat No. 7*, into a salvage boat for raising sunken river steamers. She was twin hulled with each hull having seven watertight compartments. In Ead's first letter to the Secretary of the Navy proposing arming river steamers for combat on the Mississippi, he outlined a plan for modifying this vessel for wartime use. His own description of the proposed conversion follows:

> She was built with two hulls, about twenty feet apart, very strongly braced together. . . . I had the space between the two hulls planked so that a continuous bottom extended from the outer side of one hull to the outer side to the other. The upper side was decked over in the same manner: and by extending the outer sides of the two hulls forward until they joined each other at the new stem. . . . the twin boats became one wide substantial hull. The new bottom did not extend to the stern of the hull, but was brought up to the deck fifty feet forward of the stern, so as to leave space for a central wheel.[15]

Eads was the prime contractor for the City-class ironclads as well. He describes the *Benton* as being twice the 500-ton displacement of that class. The *Benton* was unique among the early ironclads in that its casemate was completely iron armored. Its thickness ranged from 2½ inches on the forward face of the casemate and first 60 feet of its port and starboard sides to five-eighths of an inch over the rest the casemate. This armor was backed with from twenty to thirty-four inches of wood.

Internally, the vessel was carefully divided into numerous watertight compartments (recall the earlier discussion of hull flexibility in river steamers). As might be expected, the tendency for a shallow hull with broad beam dimensions to hog was considerably exacerbated by the addition of the great weight of iron armor. Modifications to the *Benton* would add an estimated 260 tons of iron armor and almost 48 tons of naval ordnance.[16] The 308 ton total weight of iron does not include the heavy weight of the bulwarks constructed to carry the armor and armament.

The *Benton's* internal watertight bulkheads were of light wooden construction. Unlike their steel counterparts in modern warships these bulkhead's effectiveness as watertight barriers was limited by the relatively greater flexing of the vessel's hull and the crude materials used to caulk the bulkhead seams.

The vessel was also equipped with steam powered pumps to enhance its survivability. Interestingly, the use of steam to power auxiliary machinery would prove to be scourge and benefit in about equal measures. Typical auxiliary machinery on the *Benton* and other period riverine war vessels included anchor winches, capstans, bilge pumps, feed pumps and turret mechanisms. All this machinery and the boat's main engines drew steam from a common plant. As a result, the mechanical advantage resulting from utilizing steam power was offset in military application by the danger of a lucky hit to the steam plant disabling the boat's vital auxiliary machinery.

Another interesting feature of the *Benton* was her propulsion mechanism. Previously in this chapter, the attributes of stern and sidewheel propulsion mechanisms were discussed. The *Benton* featured a propulsion mechanism which was a hybrid of both these systems. Where normal sternwheelers featured two engine/machinery sets which powered a common wheel, the *Benton's* machinery powered two wheels, mounted side by side in a centerline sternwheel configuration. The wheels were independently controllable. While this system should have improved the maneuverability of the vessel, in practice, this was not the case. Donald Canney elaborates on the *Benton's* primary weakness, discovered during her first river trials.

> She did not exceed 2½ knots against the current and made 5½ knots in slack water. At full steam (145 pounds pressure) she was unable to back against the current, and counter-rotating her paddles would not bring her around without assistance from her two rudders. It required a sluggish eight to twelve minutes to bring her around.[17]

As modified the vessel displaced over 1,000 tons. Measuring 187 feet overall by 75 feet of beam, she was unusually broad for her length. She did not receive larger machinery, nor a higher capacity steam plant during her conversion. These three factors combined led her various commanders to characterize her as slow and almost unmanageable. Regardless of the faults in her powerplant, the *Benton's* sixteen gun battery was the heaviest battery of any vessel in the war. Her forward battery of four large guns was exceeded only by that of the *Tuscumbia* in throw weight. This armament was invaluable in executing Federal bow attack tactics.

City-class Ironclads

The first of the purpose-built ironclads of the war on the Western waters were those of the City-class. Named for prominent river ports, the vessels of the seven ship class were the *Mound City, Cairo, Pittsburg, Louisville, Carondelet, Cincinnati* and *St. Louis* (changed to the USS *Baron DeKalb* when the Western Gunboat Flotilla transferred to the Department of the Navy in late 1862).

As noted, General Scott's "Anaconda Plan" called for establishing a force on the Mississippi and its tributaries for the purpose of strangling Confederate commerce in the region west of the Appalachians. In 1861, Scott ordered his chief engineer, one Brigadier General Joseph Totten, to evaluate conditions, geography, facilities, resources, and available shipping on the Mississippi and Ohio Rivers. Totten, in turn, made a request of John Lenthall, the chief of the Navy's Bureau of Construction, for assistance in conducting a study of the feasibility of building armed steamers for river service. Lenthall's assessment was negative, expressing the doubt of its author that such vessels would be particularly "efficient." Nevertheless, he proposed a design for a vessel which he thought suitable for the task. His design was a double-end, sidewheel steamer, with dimensions of 170 feet overall length, a 28-foot beam and a draft of 4 feet, 7 inches. The steamer's proposed armament was four 8-inch guns. Lenthall estimated the vessel's displacement at 436 tons. Included in his report was a recommendation for Totten to consult S. M. Pook, a noted expert on warship construction. Totten liked Lenthall's proposal and recommendations and included them in his report to General Scott. Scott liked Totten's report and forwarded it to Secretary of War Cameron with his own recommendation that a gunboat fleet of sixteen vessels of Lenthall's design be constructed to conduct the war on the Western waters. In spite of a lack of enthusiasm on the part of Secretary of the Navy Gideon Welles, Lenthall's plans ended up in the hands of Commander John Rodgers and Samuel Pook.

Pook's own specification called for a flat-bottomed, three-keeled, single-end vessel of 175 by 50 foot dimensions drawing 6 feet of water. This hull would float a casemate pierced for thirteen guns. James Eads of St Louis won the contract for their construction in August 1861. The contract called for the delivery of seven gunboats by October of the same year.[18] The original specification called for these vessels to be armored with an estimated seventy-five tons of iron plating to protect the boat's machinery. A later change in the specification increased the plate

from 75 to 122 tons, facilitating the use of 2½ inches of iron to plate the forward face of the casemate and the area abreast the vessel's powerplant. The class was also designed with an armored pilot house.

The most common military action against Federal steamers was sniper fire. Both sides of the conflict knew Association Pilots were the best qualified men to cope with the navigational hazards of the Western rivers. Consequently, these men and their place of work, the pilot house, were the primary targets for snipers. To counter their actions, the pilot houses of virtually every military steamer, from ironclad to transport, had some sort of armor protection. In the case of the City-class this armor took the form of 1¼ inch iron plating over 12 to 19 inches of oak backing.

As the world's first purpose-built riverine ironclads, the City-class vessels were unremarkable in their design and construction. That construction, in form and technique, was typical of the commercial river steamers of the era. There was nothing remarkable about the vessels' powerplants or machinery and their propulsion was a simple sternwheel adaptation. The same techniques utilized to enhance survivability in the river steamer conversions were applied to the construction of the City-class ironclads. Powerplants were located in a protected position. Armament was mounted on the boilerdeck behind heavy wooden bulwarks. Pilot houses were armored to protect their occupants. These techniques simplified construction but also meant that when weaknesses were discovered in one vessel, chances were that they would be exploited in other vessels of the Western Gunboat Flotilla. These weaknesses would soon be uncovered in trial by combat along the Mississippi River and her tributaries.

CHAPTER 3

INITIAL TRIALS BY COMBAT

Common sense would indicate that lessons learned in the hard school of combat would be lessons quickly identified and the deficiencies associated with the lessons corrected as rapidly as emerging technologies and doctrine would permit. Chapters 1 and 2 traced the origins of the Western Gunboat Flotilla and initial efforts to create a riverine fleet to oppose the Southern insurrection in the Western theater of operations.

In this chapter, the initial combat performance of the vessels of the flotilla will be analyzed. The analysis will focus on the vessels' technical strengths and weaknesses as revealed in trial by fire. It is not intended as a criticism of tactics. Finally, this chapter will lay the foundation for a discussion in the following chapter of the series of follow-on classes of vessels which joined the flotilla too late for its initial combat.

Timberclads at Belmont

In the late summer of 1861, under the order of Brigadier General Ulysses S. Grant, the Western Gunboat Flotilla was used to reconnoiter Confederate batteries under construction on the Ohio and Mississippi rivers. This action was the first use of the newly organized flotilla in combat operations. The sorties could best be described as reconnaissance by fire missions. They were conducted for the purpose of determining the strength of Southern forces along the banks of the rivers constituting the North's southern boundaries in the Western theater. The area of most immediate concern in the late summer of 1861 was the vicinity of the Confederate stronghold at Columbus, Kentucky.

The only vessels ready for action at this early date were the timberclad gunboats *Lexington* and *Taylor*. These vessels operated in coordination with elements of General Grant's forces based out of Fort Defiance at Cairo, Illinois. In fact, the earliest joint operation on the Mississippi River involved embarking "about one hundred of the troops of the Ninth Illinois Regiment and approaching Confederate fortifications at Columbus."[1] This reconnaissance revealed the presence of completed fortifications and others in various stages of construction on the bluffs of the Kentucky side, and at water level on the Missouri side of the Mississippi River. These fortifications were constructed at a turn in the river where the channel became deep and narrow. The lowest of the Columbus (Kentucky side) batteries was apparently fifty feet above the river. The deep, narrow channel and resulting locally swift current created a hazard to navigation exacerbated by the guns on the bluff. The total battery at Columbus amounted to more than twenty-six pieces of ordnance of one type or another.[2]

During the months of September and October 1861, Captain Foote's gunboats sortied on nine different occasions to exchange long range gunfire with the fortifications and reconnoiter their defenses. The Federals claimed to have scored several hits on the works at Columbus during this period while the Confederates' return fire passed harmlessly overhead.[3] Even at this early stage in the development of the Western Gunboat Flotilla, its leaders were well aware of the vulnerability of the timberclads to cannon fire (recall that these vessel's oaken armor was only intended to be proof against rifle fire and possibly shrapnel from field artillery).

The typical field artillery piece of the era threw projectiles ranging in size from six to thirty-two pounds depending on the type of piece: gun, rifle, mortar, or howitzer. The lighter 6- and 12-pounder guns dominated numerically throughout the war. The largest field piece regularly used was a 20-pounder Parrott rifle. Depending on the caliber, the standard 6-pounder had a bore

slightly larger than three inches. Maximum range for the projectiles fired from field artillery pieces was between 1,500 and 2,500 yards.[4]

Artillerists of the period had a wide variety of projectiles to choose from. The most common types included solid shot for use against vessels and masonry fortifications, shell for use against personnel, earthworks and wooden vessels, and grape shot and canister for use against personnel. In actual combat, the rule of thumb was that anything available was used against personnel.

Fuse technology for shells was very crude by today's standards. Time fuses of the day were little more than powder trains in wooden or metal plugs. They were lit by the explosion of the propellant powder charge during the cannon shot. Achieving lethal effects on troops in the open using airbursting shells was extremely difficult given this level of fuse technology. The vast majority of shells fired either burst higher than their effective lethal radius, low ordered on impact with iron or masonry or else buried themselves in soft wood or earthen bulwarks where the energy of their blast was absorbed. The latter could have serious consequences for wooden-hulled vessels.

Wood, due to the nature of its grain, is resistant to pounding and penetration by projectiles. Of course, the size of the projectile and the variety and thickness of the wood have a lot to do with the degree of resistance, but the theory that a wooden structure tends to disperse the energy of an impacting projectile is basically sound. Therefore, given a thick enough wooden bulwark and a small enough shell, the bulwark should resist penetration. The trouble with shell is that once it buries itself in a vessel's wooden bulwarks, it explodes. This explosion reveals the weakness of wood as armor. That is, the very grain which dispersed the shell's impact contributed to its splintering and fragmentation when exposed to a shell's detonation.[5]

Naval guns and heavy siege and seacoast artillery presented a much more lethal threat to the riverine vessels than field artillery. The most common cannon mounted at Confederate river fortifications were 32- and 64-pounder guns; depending on caliber, roughly 6- and 8- to 8½-inch projectiles respectively. Shot and shell fired by cannon of this size would penetrate most unarmored wooden bulwarks. While iron armor was generally proof against penetration, hits from heavier pieces caused considerable damage to the heavy wooden bulwarks backing the iron of ironclad vessels.

When Commander Rodgers began modifying river steamers for military use, he had tests conducted using a 12-pounder field gun to determine the thickness of iron required to resist penetration by light artillery fire. His gunners fired solid shot against a 12-inch-thick wooden target faced with 2½ inch thick iron. The shots were fired with a standard powder charge from progressively closer ranges. At one hundred yards, when shrapnel from the shot breaking up against the plate forced Rodgers' men to discontinue the test, the plate, although dented, had not been penetrated. Rodgers' conclusion was that the 2½ inch thickness of iron when mounted on his vessels under construction would be adequate in protecting them from any foreseeable enemy fire.[6]

During the test the target was mounted at a thirty-five degree angle in order to simulate the geometry of an ironclad's casemate. The angle was obviously intended to lessen the impact of shot and shell by deflecting the force of the blow of a projectile hit upward. The theory was sound. Unfortunately there is no indication that the test took into account the most likely trajectory for the ordnance of the era.

According to present day artillery experts, the standard cannon of the era fired a projectile into a fairly flat trajectory out to one-half to two-thirds of its maximum range. The Mississippi was the widest river in the basin and even it had an average width of only a little over one mile.

Because the riverine fleet normally tactically deployed in a line abreast formation, it is reasonable to assume its vessels spent the majority of their combat time at ranges where Confederate cannon projectiles were traveling on a flat trajectory. Since descriptions of fortifications later attacked by Federal vessels are notably similar, the elevations relative to river level of the batteries at Columbus, Kentucky, can be considered to be representative of the fortifications along the entire Mississippi River. With few exceptions Confederate batteries were in elevated positions. Assuming an average battery elevation of seventy-five feet and allowing for normal downward acceleration in its ballistic path, the laws of physics dictate that a projectile fired from a gun emplaced in one of these batteries will strike its target with some vertical velocity and downward angle. Of course windage, imperfect rifling , imperfect projectile shape, friction, and assorted other factors combine to influence the final impact angle, but for the purposes of illustration the end result is more or less the same. The slope of the typical ironclad casemate must have often resulted in a ninety degree projectile impact. The factors discussed, in combination with an unfortunate propensity for gunboat skippers to run past gun batteries at short range, all combined to negate the glancing effect of sloping gunboat casemates.

Period photographs of the *Lexington* and *Taylor* show that neither vessel possessed a sloping casemate. During the Battle of Belmont these vessels were pressed in service as escorts for a convoy of Army transports conveying General Grant's troops. The purpose of Grant's expedition was the capture or destruction of the Confederate force and batteries commanding the river opposite Columbus at Belmont, Missouri. Grant's general order for the first true joint action of the war read as follows:

> The troops comprising the present expedition from this place, will move promptly at six o'clock this morning.
>
> The gunboats will take the advance, and be followed by the first brigade, under the command of Brig. Gen. John A. McClernand, composed of all the troops from Cairo and Fort Holt. The second brigade, comprising of the remainder of the troops for the expedition, commanded by Colonel John Dougherty, will follow.

> The entire force will debark at the lowest point on the Missouri shore, where a landing can be affected in security from the rebel batteries. The point of debarkation will be designated by Captain Walke, commanding naval forces.[7]

In carrying out Grant's orders, Commander Walke positioned his vessels to fire at the batteries on the bluffs at Columbus. This act was intended to draw the fire of the Confederate batteries away from Grant's troops during their landing. During the engagement Walke's gunboats "kept constantly moving, while engaged, in a circle, to elude the enemies shot."[8] Accomplishing the mission of supporting Grant's landing and well aware of the vulnerability of his vessels to cannon fire, Walke withdrew out of the line of fire of the Confederate batteries. Apparently, Walke could not stay away from the fight. Perceiving that the rebels were renewing their attack on Grant's forces after his withdrawal, Walke again maneuvered his vessels into line of sight with the Columbus batteries and for a period of about thirty minutes fired on them with impunity. The rebel batteries had difficulty ranging the Federal gunboats. The exact reason is not clear, but for these thirty minutes the heavy Confederate ordnance passed harmlessly over the circling Federal vessels. When they eventually found the range and projectiles began landing close by the gunboats, Walke again withdrew.

By this time Grant's land forces had captured the rebel camp at Belmont and were in the process of sacking and burning it. Seeing this, the Confederate commander at Columbus turned his batteries on the camp. In the meantime, the Confederates were landing troops by riverboat on the Missouri side downriver from Belmont with the intention of flanking Grant and cutting off his retreat to his transports. Walke's gunboats opened fire on the Confederate reinforcements' landing site from across the point at the river bend. Official accounts are unclear, but it is thought that this action caused the Confederates to land their reinforcements farther down stream to avoid the Federal fire. Note that the heavy batteries on the Columbus bluffs prevented Walke from pursuing the Southern transports downstream. His vessels were too vulnerable to risk prolonged

exposure to their fire. In spite of this, the fires from Walke's gunboats contributed to Grant's escape by delaying the arrival of Southern reinforcements. Having destroyed the camp at Belmont, Grant found rebel troops between himself and his transports; those vessels waiting upriver from Belmont. With rebel reinforcements in pursuit, Grant's forces had to fight their way through to the transports. As the Federal troops were boarding the transports, Walke was informed of the imminent arrival of the Confederates. He positioned his gunboats to support the withdrawal. As the Confederates broke into the landing site, they came under heavy fire from the batteries of the gunboats. In a letter to the *Ohio State Journal* quoted by Henry Walke, a correspondent who witnessed the battle speaks of carnage created by Walke's two vessels reporting: "Over seventy rounds of canister [grape], ball and shell were poured into their ranks from the two gunboats in less than thirty minutes, without which it may be doubted whether our force could not have been cut off."[9] The same witness was very impressed by the performance of the gunboats. Later in his report he extolls the virtues of the vessels saying,

> It will thus be perceived that the presence of our gunboats, compelling the enemy's transports to land below our troops, not only saved that portion of the Federal army which retreated to the landing and re-embarked under their guns, but that also which took the road to Charleston, and reached the river above the place of debarkation, and were received on board the gunboats, which could not be approached by the enemy.[10]

The apparent success of the gunboats was not without its cost. In his effort to draw and suppress rebel fire Walke's gunboats made a total of three runs in range of the batteries at Columbus. On each occasion struck by artillery, the light oaken armor of his vessels was pierced. Confederate shot and shell "came down obliquely through side deck and scantling"[11] causing several casualties. Walke's maneuvering and the inexperience of the Confederate gunners at hitting moving targets with their bluff-mounted guns allowed a small naval force to carry the day for the Federal forces.

The primary lessons learned at Belmont were: timberclad vessels were highly vulnerable to even light artillery fire; heavy naval guns were extremely valuable when used in direct support of ground forces; gunboat escort was invaluable in protecting Army troop transports (Union); and troop transports are exceptionally vulnerable to gunboat attack (Confederate).

The success of Walke's gunboats was purely a matter of his leadership and the shock effect of his vessel's heavy guns on troops in the open. In this battle, the greatest assets of the gunboats were speed and maneuverability. Walke's ability to support Grant's forces hinged on his ability to draw and suppress enemy fire at critical times without sustaining significant damage to his own vessels. Flag Officer Foote did not take part in this action and it is doubtful that he recognized this significant fact for the tactical lesson that it was. The flotilla's next engagement, fought at Fort Henry in northwestern Tennessee, involved four new vessels and different tactics. It was the first combat action for vessels of the City-class and it would serve to highlight several weaknesses in their design and construction.

Fort Henry: The First Trial of the City-class Ironclads

Grant's raid at Belmont took place on November 7, 1861. Major General Henry Halleck took command of the Union forces in the West two days later. According to author Fletcher Pratt in his book *Civil War on Western Waters*, Halleck had the reputation of being an "orderly soldier, who did everything by the rules, which meant that he did things slowly."[12] Based upon the number of sources that agree with this assessment, it is probable that his reputation was justified. Halleck did virtually nothing in his theater of operations until Lincoln ordered him to action in January 1862. Lincolns orders compelled him to conduct reconnaissance operations against Columbus and Forts Henry and Donelson with the intent of preventing the Confederates from reinforcing their positions in Tennessee and Kentucky.

A highly respected Union officer Brigidier General Charles F. Smith, was in charge of the reconnaissance conducted on Fort Henry. Early in the war the belligerents made a show of respecting the neutrality of Kentucky. Because of this policy the Confederates built Fort Henry right on the border between the two states. The site selected for the construction of the fort was on the muddy bottomland of the east bank of the Tennessee River. The fort was inundated during high stages of the river. To partially offset the militarily unfavorable position of Henry's batteries, Fort Heinman was under construction on the bluffs situated on the opposite side of the river. Unfortunately for the Confederates, Smith recognized and reported the vulnerability of the fortifications to Grant, who, with help from Foote, convinced Halleck of its strategic importance.

The Battle for Fort Henry would be the first time Federal gunboats would face a serious threat from torpedoes. In Civil War era parlance torpedoes were naval mines. These mines came in two varieties: electrically or mechanically detonated. Both types employed roughly 50 to 120 pounds of blasting powder packed into either a waterproofed wooden or metal cask, or a glass demijohn. They were powerful enough to sink any vessel afloat on the western waters. The design and construction of these devices was initially local in nature, at least until October 1862, when the Confederates established their Torpedo Bureau under the leadership of Brigadier General G. J. Rains. During the era of the Civil War, the materials available to support mine technology were quite primitive by today's standards. Waterproofing the mines and achieving consistent detonation were tasks which tested the limit of the materials available to Southern ordnance fabricators. As a result, their reliability varied considerably. Unfortunately for the Union cause, what these devices lacked in reliability and technical sophistication was more than offset by the ingenuity of their design and the great numbers in which they were employed. Although Confederate torpedoes sank thirty-nine vessels (including six warships) during the war, their impact could have been much greater, given the light construction of period vessels.[13]

The vessels involved in the assault on Fort Henry were the *Essex, Cincinnati, Carondelet, St. Louis, Taylor* and *Conestoga*. The Tennessee River was at an unusually high stage for the season. The high water, caused by melting ice and rains, and an unusually rapid current filled the river with a great deal of debris. The Confederates had laid a considerable number of torpedoes in the vicinity of Fort Henry in an attempt to protect its river approaches. When the Tennessee rose and the debris swept downriver it served to tear the torpedoes loose from their moorings.

When the Federal vessels advanced upstream they were slowed by two things. First, the debris floating down river (predominately large uprooted trees) formed large rafts which fouled on the bows of Foote's flotilla as it chuffed upstream to attack the fort. In his account of the action, Commander Henry Walke, now commanding the *Carondelet*, describes the difficulty he had in dealing with the debris and the current which pushed it:

> The swift current brought down great quantities of driftwood, fences and lumber, with large trees; and it became a most difficult task for the fleet to disentangle itself. Great masses of driftwood lodged around the "Carondelet's" bows, dragging her down river over half a mile with both anchors down, and it was only by keeping full steam power working against the swift current all night, that the crew were able to "clear the wreck."[14]

The delay caused by the effort required to "clear the wreck" was timely in that while the vessels of the flotilla were thus engaged, they spotted the torpedoes, previously torn loose from their moorings, floating downriver in their path. Flag Officer Foote ordered the *Taylor, Lexington* and *Conestoga* to "intercept them with their small boats and drag them ashore."[15] The mine clearing operation occupied an additional day.

The theme of detaching the light draft timberclads for this type of work is one which will repeat itself throughout the western waters campaign. Where speed and maneuverability were required, the timberclads were employed. Indeed, at the Fort Henry battle, steaming against the current, the ironclads could make only about three knots headway.[16] The obvious result was that, in the heat of battle, these vessels were little better than stationary targets. To be fair, the City-

class ironclads, with 2½ inch armor on the forward faces of their casemates were designed to attack targets bow on. This indicates that Pook and Rodgers were well aware of the effect the vessels' anemic powerplants would have on maneuverability.[17] Almost without exception, secondary sources and period accounts of the battles describe the tactical employment of these vessels in line abreast, bows on formations, deployed in line of battle into the existing current. The practice of mounting the heaviest guns in the vessels' forward divisions resulted in a formidable array of firepower facing the enemy while in theory exposing the vessels' most protected area to their fires. Foote's flotilla tested the tactic at Fort Henry. The result was success and failure in roughly equal measure.

First of all, the Confederates surrendered after 1½ hours of vicious pounding by Federal gunfire. This success was offset by the confirmation during the action of two serious weaknesses in existing ironclad gunboat design. A newspaper correspondent who witnessed the battle from the flotilla's flagship, the *Cincinnati*, describes the damage done to that vessel saying,

> The 'Cincinnati' received thirty-one shots, chiefly damaging her where she was not iron plated. Her chimneys, pilot house, after cabin, and boats were completely riddled. Two of her guns were disabled. One was struck by a 68-pounder on the muzzle. A 32-pounder shot struck her on the side, and dented the iron. The only fatal shot from the fort passed through just at the larboard front, killing one man instantly, carrying his head away, and wounding several others.[18]

USS *Essex* Second Master James Laning makes a similar account of the damage sustained during the battle. Laning, somewhat less descriptive than the unknown correspondent on the *Cincinnati*, details the more severe damage done to his vessel, saying, "A shot from the enemy pierced that casemate just above the porthole on the portside, then through the middle boiler, killing Acting Masters Mate S. B. Brittan, Jr., in its flight, and opening a chasm for the escape of the scalding steam and water."[19] In total, the *Cincinnati* took thirty-one hits, the *Essex* fifteen, the *St. Louis* seven, and the *Carondelet* six. Although none but the single hit to *Essex* were vital, they illustrate the extreme vulnerability of the unarmored portions of the vessels to heavy cannon fire and the

ease with which even an undermanned battery such as those at Fort Henry could score hits on the lumbering ironclads.

These hits were not without effect on the performance of the vessels, or the ability of the crews to fight their craft. At some time during the battle, Confederate cannonfire forced the pilots and captains of all the vessels away from their stations in their respective pilothouses. Hits on these vital structures which failed to penetrate, often resulted in injuries to its occupants from shell shock and splinters.[20] The occupants of the casemate were subjected to the same splinter hazard. In addition, they faced the hazard of cannon and rifle fire directed at the gunports. The damage *Cincinnati* sustained to her guns was evidence of this vulnerability.

Because of the importance of firebox draft in sustaining steam pressure in a vessel's powerplant, the "riddling" of a vessel's chimney resulted in decreased draft and subsequent decrease in powerplant performance. In the long run, holes in the vessel's superstructure decreased their habitability and seaworthiness as well. After the battle, the crew and interior of the vessel were exposed to the elements. Additionally, various sources describe the effect of sustained heavy impacts on the hull and superstructure as serving to "loosen the seams" of a vessel, causing numerous leaks.

Walke, in his account of the action, states that "one of the prisoners had the specifications of the construction of the gunboats, and they knew where to strike them in the most vital parts."[21] This assertion was absent in all of the secondary sources available to the author describing the battle. If Walke's account is taken at face value, the assumption can be made that not only were the Federals aware of their vessel's vulnerabilities, but that after Fort Henry they knew the Confederates were also aware of these vulnerablities and were taking steps to target them.

The Federals knew of the vulnerability of their vessel's steamplants to enemy fire. The damage incurred by the *Essex* is the first example of how catastrophic a hit to a boiler or steam

drum could be. Even under peacetime conditions, the sheer physical size of the plant, filled as it was with its considerable volume of steam, superheated and under high pressure, constituted a bomb waiting to go off. When holed, the steam from the plant escaping into the confines of a vessel's gundeck had a devastating effect on the crew. In the case of the *Essex* at Fort Henry, thirty-two men were killed or wounded by scalding steam, including her skipper, Captain W. D. Porter. Once the plant's steam pressure was vented, the vessel was without propulsion and at the mercy of the wind and current.

Again, the tactics employed by the Federals seemed to anticipate disaster. Most sources indicate that by attacking into the current, vessels were spared further enemy fires because, when disabled, they would drift downstream away from enemy guns.

Western Gunboat Flotilla Bloodied at Fort Donelson

In terms of the damage they sustained accomplishing the military objective of taking Fort Henry, the Western Gunboat Flotilla achieved considerable success. To a much greater degree, the next battle it fought, at Fort Donelson, highlighted the vulnerabilities of its vessels. The battle at Fort Donelson differed from that at Fort Henry in two very important ways: the forts guns were mounted in much better (higher) positions and they were manned by a much larger force. The Federal battle plan called for the flotilla to steam upriver and destroy the fort's small river level battery at close range. This being accomplished they would steam past the fort and enfilade it "from its open rear."[22]

While their success against the river level batteries at Fort Henry bolstered confidence in the ability of the gunboats to withstand the fire of Fort Donelson's river battery, there was considerable concern over the possible effect of plunging fire from that fort's bluff mounted guns. As a result, the flotilla's captains directed their crews to add an unusual variety of improvised "armor" to their vessels. The *Carondelet* had her boilers sandbagged, more than likely in

response to the fate of the *Essex* at Fort Henry. Lieutenant Egbert Thompson, commanding the USS *Pittsburg*, had:

> 100 bread bags filled with coal piled around the boilers as some protection against solid shot. Against the bags the crew stacked their rolled hammocks. . . . In all the gunboats, chains, lumber, and bags of coal were laid along the vulnerable upper deck in hopes of deflecting plunging fire.[23]

In carrying out the Union battle plan, Foote's flotilla closed to within 150 yards of the lower battery. In doing so, not only did it come under murderous plunging fire from the batteries on the bluffs, but it ran so close to the river bank that its gunners could not elevate their guns sufficiently to bring fires on the enemy guns mounted there.[24] Every vessel was hit at least 50 times. Unlike the action at Fort Henry, these hits were predominately to the unarmored portions of the vessels.

A close examination of the drawings and specifications from the *USS Cairo Historic Structure Report* sheds light on the strengths of a City-class ironclad's defensive armor. The only portions of the vessels that were armored were the forward face of the casemate and a sixty-foot section on the port and starboard sides of that structure abreast the gunboat's machinery. The "armor" for the rest of the vessel constituted four inch thick oak planking over a ten by ten inch timber framework. These timbers were set on eighteen inch centers. The most vulnerable portion of the entire vessel was the hurricane deck. This deck was essentially the overhead (ceiling) for the gundeck. The total overhead protection offered by the deck's structure was provided by 2½ inches of white pine planking laid over seven inch carlines set on two foot centers. To make matters worse there was an eight by sixteen foot skylight cut in the deck for the purpose of ventilating the gundeck. In building the timberclads Rodgers had determined that it took five inches of oak to stop a rifle bullet. The hurricane deck on this class of vessels did not even offer this minimal protection.[25]

The batteries at Fort Donelson were mounted in three tiers whose elevations above the river were 25, 50 and 120 feet respectively. According to the account of Brigadier General Floyd Pillow, the Confederate commander at the fort, the Confederates held their fire until the gunboats were well under the guns of the bluff batteries.[26] The damage inflicted upon the flotilla when the Confederates finally opened fire was considerable. The *Louisville* had her tiller ropes shot away. The flagship, *St. Louis*, was struck in the pilot house, killing the helmsman and wounding Foote. *Pittsburg* had her foredeck penetrated, badly damaging the hull below. In addition, she too had her steering gear shot away and was hit in her pilot house. The *Carondelet* was probably the hardest hit of all. She sustained shots to her steam heater,[27] foredeck and pilot house before the *Pittsburg*, out of control with her tiller ropes shot away, collided with her and knocked off her starboard rudder.

As already mentioned, all these vessels suffered from poor maneuverability to begin with. The fact that their steering gear was mounted in an exposed position on their fantails made this weakness doubly dangerous in combat. The rudders and tiller bars of the vessels of the class were also exposed and clearly visible to the enemy. As a result, they were obvious and highly desirable targets.[28] If the Confederates were indeed targeting this tackle as one of the vulnerabilities of the class, then their marksmanship was excellent.

The wounding of Flag Officer Foote further illustrates the vulnerability of the pilot house. According to one account, the shot that injured Foote was a plunging, solid shot which "struck the texas square" and ripped through more than one inch of iron and thirteen inches of oak before it struck the vessel's wheel, killing the pilot instantly.[29]

The battle for Fort Donelson also revealed a flaw in the armament of the vessels. That armament was a most diverse collection of old and new weapons, acquired from both Army and Navy sources. It is apparent from various sources that these cannon were acquired in a piecemeal

fashion, from any available source. The intent of the "acquisition" was more a matter of filling an empty gunport than creating a truly effective battery. In *The Old Steam Navy*, Donald Canney describes the variations among the seven City-class ironclads.

> All seven vessels carried thirteen guns each, ranging from 30-pounders to 100-pounder rifles. The Cairo originally mounted six 32-pounders (43 cwt.), three 8-inch (64-pounder) smoothbores, and three 42-pounder army rifles, plus one 12 pounder. . . . Another battery variety can be seen in Baron DeKalb after May 1863: Bow: one 10-inch and two 9-inch Dahlgrens; stern: 30-pounder rifles; broadside: two 8-inch and six 32-pounders. Probably the heaviest battery was on the Pittsburg in December 1863: one 100-pounder, four 9-inchers, two 8-inchers, four 32's, two 30's, and one 12-pounder.[30]

This arrangement was a supply officer's nightmare. One of the more common results of this diversity was the receipt of an occasional shell that did not fit a gun as well as it was suppose to. One of *Carondelet's* bow gun crews experienced this irregularity during the action at Fort Donelson. An unknown *Carondelet* crewman describes the disaster that ensued.

> Our boat has three bow guns, two rifles, and one smooth-bore sixty-eight. The rifles are about 84-pounders. Our bow being iron-plated, we have always fought 'head-on.' Several of our rifled shell were a little too large, and would stick in the gun about halfway down. Gunnery requires they should be withdrawn, but when you are close to the enemy's batteries, you cannot lose time by drawing them out, so we blazed away at them, home or no home. The gun was run out when it burst, or the damage would have been greater than it was, I sincerely trust that the like may not happen again.[31]

The crew failed to ram the shell all the way against the powder charge in one of *Carondelet's* old Army 42-pounders. The resulting over-pressurization outside of the reinforced breech caused the barrel to burst, wounding more than a dozen men and causing considerable confusion on the vessel's gundeck.

Rammers were marked with rawhide strips or paint marks to indicate when a shell had been properly rammed home. Unfortunately, the gundecks of these vessels packed thirteen heavy guns firing within a relatively small, enclosed space having a seven foot overhead clearance. The noise level was debilitating and shell shock and burst eardrums were the order of the day.[32] In the

mind-numbing din of battle, gunners often made mistakes loading, with predictably disastrous results.

The Western Gunboat Flotilla got a bloody baptism of fire at Fort Donelson. At least two of the Flotilla's vessels were damaged at their waterlines. Civil War accounts refer to a waterline as the area between wind and water. When damage was inflicted below this point, on a vessel constructed with the primitive "watertight" divisions of the era, the resulting flooding often proved fatal. Damage control options available to combat underwater damage were limited. A vessel damaged below her waterline was generally run aground to await later salvage. Federal vessels sunk by torpedoes during the course of the war provide the best examples of the outcome of sustaining underwater in combat; they invariably sank in less than thirty minutes.[33] Fortunately for the Union riverine effort, short of encountering a torpedo or having a lucky plunging shell punch out through a vessel's bottom, this type of damage was rare and difficult to inflict. The water surrounding the lower hull offered more complete protection against the ordnance of the day than any iron armor. Damaging a vessel at her waterline was a much easier proposition. However, while this type of damage could also caused flooding, that flooding usually occurred at a lesser rate and was more easily contained.

The era of the Civil War marked something of a transition period in naval gunnery, at least in the United States Navy. Given the primitive state of technology for aiming cannon and complete lack of platform stabilization available during the Civil War era, it was difficult to obtain accurate gunnery from the rolling decks of vessels at sea. Accuracy was certainly poorer than that of land based artillery. The nautical solution to this deficiency was to de-emphasize the use of direct fire in ship to ship combat at long range. The process of "skipfiring" cannon was a technique which had been in use as long as guns had been mounted on ships. With the technique, a ship's guns were fired at a low elevation so that their shot would ricochet across intervening

water and strike an enemy ship's hull close to the waterline. By the late 1840s naval ordnance was reasonably accurate when fired at ships in this manner out to ranges of roughly 600 to 2,000 yards. A rifled weapon's principal advantage over smoothbore types lies in its greater accuracy. These weapons, due to the spin they placed on their projectiles, did not skip true. As a result, the leadership in the Navy's Bureau of Ordnance did not emphasize rifled weapons as much as he might have.[34]

Interestingly, many sources indicated that in order to create confusion, Army artillerists on both sides of the conflict skipshot solid shot into troops formations. This technique was used by the Confederates in the lower batteries at Fort Donelson against the federal flotilla with considerable success. Evidence of the success is found in the damage sustained by *Carondelet* and *Pittsburg*. After the action at Donelson both these vessels were forced downstream toward Federal bases in Southern Illinois. There, they would be pulled on the Marine Ways at Mound City, Illinois, to effect badly needed repairs.

Repairs and Modifications

Throughout the war, the principal repair base for the Western Gunboat Flotilla was located at Mound City. Located at Ohio River Mile 974, about eight miles upriver from Cairo and the confluence of the Ohio and Mississippi Rivers, Mound City was ideally situated to support operations on the Ohio and Upper Tennessee, Cumberland and Mississippi rivers.

The technically uncomplicated construction of riverine war vessels facilitated their rapid repair, as did the layout of the repair facilities available at Mound City. This facility was the navy yard that Foote professed to need so badly and that Lincoln eventually authorized in 1862. David Dixon Porter, who would command the Flotilla when it transferred to Navy control in October 1862, highly approved of the facilities. This is obvious from his description of the Mound City yard.

> When the station was subsequently established at Mound City, just above Cairo, the Union exulted in the possession of a real navy yard of some ten acres, which although sometimes under water from freshets, soon grew to a respectable size, although its machine shops, carpenter shops, etc., were all afloat in steamers. . . . This, then, was all the establishment of the Navy Department at that time considered necessary to keep in repair the Mississippi Squadron.[35]

The process of "pulling" a vessel for repair was unique to riverboat construction and repair. The marine cradleways were the heart of the Mound City repair facilities. As such, the yard possessed eight of these structures, essentially concrete tracks built perpendicular to and descending down graded banks into the Ohio River. When a vessel was pulled, it was maneuvered parallel to the river bank onto submerged boat cradles. The cradles were large wheeled carriages mounted on an iron track running the length of the top of the cradleways. They supported the hull of the vessel when it was pulled out of the water. The cradles were large enough to handle any of the vessels of the Western Gunboat Flotilla except the *Benton* and *Essex*.[36] While there were eight cradleways available at the facility, only one vessel could be pulled for repair at any one time. The cradleways were each 16 feet wide and spaced 20 feet apart, giving a total width of 248 feet. According to ship yard records, the longest vessels pulled at the yard exceeded 300 feet. At any rate, the cradles were all attached to a common control house via a system of cables and pulleys. This system allowed all the cradles to be pulled at the same rate by a common steam plant. By this process, vessels of various length were pulled utilizing at least two, but up to all eight, of the facility's cradleways.[37]

Once exposed, the vessels were easily repaired. While Mound City did not possess a significant iron related industrial base, it did have a "marine sawmill." Thanks to the close proximity of an abundant timber supply from the Cache River basin and the predominantly wooden construction of the flotilla's vessels, the facility was more than adequate to support the structural repair requirements of the organization. The floating machine and carpenter shops described by Porter are mentioned in various sources and were located at Cairo as well. They

augmented locally available metal fabrication and machinery repair facilities. Similar vessels housed troops and casualties and served as storehouses for supplies and ammunition throughout the war.[38]

Throughout the early months of their service, modifications to the City-class were made in response to design flaws and weaknesses identified during the vessels' first combat action. These modifications were undertaken at the Mound City facility. Because a flood and neglect destroyed most of the Mound City Marine Ways records in 1937, details as to the exact nature of the repairs and modifications no longer exist. However, a single surviving accounting ledger provides some insight into the possible nature of the work done.

Entries from the time of the Henry and Donelson battles list expenses for extra bulkheads, moving portholes forward on the vessels' sides and closing portholes abreast the engines, installing iron beams over the boilers and altering existing and installing additional scuttles. Significant entries document the cost of "1,504 feet of oak, 8,560 feet of pine and more than $300 worth of spikes put into pilot houses."[39] There are additional entries which document wood, bolts, spikes, hog chains and caulking. These entries probably document expenses for the completion of the *Cairo* and *Mound City*, as well as repairs for damage sustained in combat.[40]

The pilot house modifications resulted in an octagonal shaped structure. The front three sides of the structure were constructed of 19½ inches of solid wood backing 1¼ inches of iron armor. The other five sides had similar iron protection backed by twelve inches of wood. Edwin C. Bearss' book, *Hardluck Ironclad, The Sinking and Salvage of the Cairo*, is probably the best available source describing the layout of the City-class vessels. While many sources describe the pilot houses of the class configured as described here, almost all of them cite either Bearss' book or the *USS Cairo Historic Structures Report* in doing so. Given that the Marine Ways ledger entries cite additional charges for work done to the classes' pilot houses, and in view of the heavy

damage and casualties inflicted in these structures during the battles at Henry and Donelson, it is likely that the pilot house found on the salvaged *Cairo* is a product of extensive modification and not the original configuration of the class.

The salvaged *Cairo* also had rail iron placed on heavy timber casings, protecting her engines and boilers.[41] This supports the ledger entry detailing the additional cost of installing "iron beams over the boilers of the vessels." The installation is a likely response to the damage inflicted on the steam plants of the *Essex* and *Carondelet.*

Pook's original specification called for gunport shutters made of a 2½-inch thickness of oak built to 46 by 48-inch dimensions.[42] At its most protected state, with guns run in and shutters closed, these structures afforded scant protection. They were essentially windows for enemy gunners to fire into. The ledger entry noting costs for closing portholes abreast the engines and moving them farther forward probably detailed work done to provide additional protection in response to the same lesson which resulted in rail iron being installed over the boilers. Another, less likely possibility is that this modification may have been an attempt to augment the forward battery of the class by improving the field of fire of the forward guns in the broadside battery. Moving them forward could have slightly increased their ability to train forward during a bows-on attack.

The alteration and addition of scuttles was undoubtedly a response to poor ventilation discovered while a significant percentage of the vessels' guns were firing at a high rate during combat. The modification was probably an attempt to clear gunsmoke from the gundeck and not an issue of improving habitability, as the vessels were launched in late fall and winter.

Island Number 10 and Improvised Armor

The victories at Forts Henry and Donelson drove a Federal stake into the heart of the Confederate Bowling Green-Henry-Donelson-Columbus defensive line. The Federal success and penetration into Middle Tennessee quickly made the position at Columbus, Kentucky, untenable for the Confederate force of Major General Leonidas Polk. With Polk forced to withdraw from Columbus, the Western Gunboat Flotilla was freed from the danger of running the batteries there. This facilitated the continuation of the Federal advance into the South, now along an additional axis: down the Mississippi River.

The next Confederate stronghold on the Mississippi River was located at Island Number 10.[43] The Confederates had created a strong battery of fifty heavy guns located on the island and on the Tennessee side of the Mississippi River opposite the island. Having advanced downstream on the Missouri side of the river, a Union force under Major General John Pope was located at New Madrid, Missouri a few miles downriver from Island Number 10. Foote had already determined by reconnaissance that artillery fire alone would not cause the Confederates manning the batteries to capitulate. Unfortunately, Pope's troops were downstream from the island and on the wrong side of the river to march on the fortifications. Since the Confederates still controlled the Mississippi downriver from Island Number 10, the Federals could not cross the river to attack the batteries from the land side without an escort to protect the crossing from Confederate guns and gunboats. The pounding Foote's flotilla had received at Henry and Donelson made him reluctant to risk his newly repaired vessels against another heavily armed fortification. However, Foote agreed to an attempt to run the batteries after two of his captains volunteered for the mission. Foote selected Henry Walke's *Carondelet* to make the first passage. Two factors somewhat lessened the danger of the passage: the *Carondelet* would make the passage in the dark; and the island's guns were all emplaced at more or less water level.[44]

As at Donelson, the crew fortified their vessel with every bit of improvised armor they could lay their hands on. Walke's description details the preparations made by his crew prior to his vessel running past Island Number 10's guns:

> the "Carondelet" went a short distance up the river, and took a barge laden with coal and hay on her port side. Where there was no iron plating on the sides of the vessel forward and aft, it was protected with bales of hay, lumber, chain-cables, &c.; the coal barge being lashed to her port quarter, to protect the magazine and shell rooms. Her upper deck was covered, also, with lumber, cord wood, coal bags, chain-cables, and hawsers: cables and ropes were coiled around the pilot house, from twelve to eighteen inches thick, and heavy timber, with all her available iron, was securely placed as a barricade around the boilers and engine room; and it was truly said, "The brave old 'Carondelet' looked like a farmer's team, preparing for market."[45]

Additionally, in an attempt at stealthy passage, Walke planned to allow his vessel to drift downriver to the bend above the island before using its engines to maneuver. The crew had routed the steam exhaust through the wheel house in an attempt to muffle the characteristic popping sound of the plant's pop valves. Steam was normally routed out the stacks, where it prevented chimney fires caused by creosote build-up. When a stack fire caused by burning creosote flared up during her run, the Federals found out the hard way that the convention was a practical one. The fire highlighted *Carondelet* for Confederate gunners.

These measures were all characteristic of the improvisation that occurred in response to the damage inflicted on the flotilla during previous battle. Lashing vessels together or lashing barges alongside became a recurring measure used to protect vulnerable side bulwarks. The protection afforded apparently outweighed the tactical hindrance of the loss of firepower due to masked guns and the reduction in the vessel's already poor maneuverability resulting from the deadweight of a hulk being lashed alongside.

Because of an "illuminating" thunderstorm and her own stack fire, the *Carondelet* was spotted before she got past the Island Number 10 batteries. However, although the Confederates fired about fifty shots at her, she was not struck by a single round during her run; most passed over the top of the gunboat. The *Pittsburg* made the run a night later with the same result.

Together the two vessels escorted Pope's troops across the river where his force was able to cut the lines of communication to the fortification and compel the Confederates at Island Number 10 to surrender.[46]

From a technical standpoint, the action was important in that it illustrates the depths to which the Federal's were willing to go to improvise protection for their vessels. The fact that they risked a night run, without navigation lights or pilot boat to assist in the passage, was an indication of the respect they had for the Confederate guns, as well as their realization of the level of vulnerability of their vessels.

The action at Island Number 10 marks the last major battle where the original vessels of the Western Gunboat Flotilla would fight without vessels of subsequent classes. After October 1, 1862 the flotilla's name would even change; becoming the Mississippi Squadron after being officially turned over to the Navy. Further permanent modifications to the City-class did occur throughout the conflict, although they were apparently ad hoc.

What modifications were made appear most often in the amount and location of armor attached to various vessels of the class. Two such examples are the *Cairo* and the *Louisville*. The *Cairo* had additional "railroad iron" attached to her casemate on port and starboard sides forward of the forward guns in her broadside batteries. It is not clear when this modification was completed, but it is obvious that it was made in response to the proven vulnerability of that area during bows-on attacks.[47] The *Louisville*, on the other hand, had her casemate side armor entirely removed at some time prior to the Red River Campaign. This modification was an effort to reduce her draft for operations on that shallow river. However, there is no record of the armor ever being restored after the completion of the campaign.[48]

Plum Point Bend: The Value of Speed and Maneuverability Revealed

Clearly, the early riverine ironclads were characterized by marginal top speed and poor maneuverability. The tactical value of these characteristics will be discussed in the following chapter; however, the disasterous result of a speed and maneuverability deficiency in the vessels of the City-class is nicely illustrated in the May 10, 1862, action at Plum Point Bend.

After the action at Island No. 10, the Federal forces continued their riverborne advance via steamer, down the Mississippi River into Southern territory. The next major fortification on the river was located just north of Memphis, Tennessee, at Fort Pillow. Like the actions previously described, the contest for possession of the fort was to be a joint affair, with the Western Gunboat Flotilla supporting Major General John Pope's troops as they landed north of Fort Pillow and attempted to encircle the fortifications there. Unfortunately, due to unfavorable terrain, Pope was unable to find a suitable route. Before he and Flag Officer Foote could devise another plan for an assault on the fort, Pope and his troops were ordered east to assist in Grant's campaign to take the Confederate rail hub at Corinth, Mississippi.

This occurrence left the flotilla with little to occupy its attention except to utilize its mortar barges to bring harassing fire onto Fort Pillow. As a result, on the morning of May 10, the vessels of the flotilla were either anchored or secured to trees along the bank of the river; their crews waiting for the Army to return so they could resume the campaign downstream. The vessels were at a low state of readiness, with steam down, when the Confederate War Department's River Defense Fleet, stationed at Memphis, sortied upriver and attacked the ill-prepared flotilla.

The Confederate "fleet" was composed of eight converted steamers. Lightly armed and armored with cotton bails, the Rebel vessels were modified and equipped with rams in a manner similar to Colonel Charles Ellet's vessels. Without heavy guns and armor, they retained much of their pre-conversion speed and maneuverability.

The *Cincinnati* was stationed as a picket at a turn in the river known as Plum Point Bend; its mission to protect the vulnerable mortar barges located in its vicinity. On spotting the approaching Confederate rams, *Cincinnati's* crew hastened to slip her moorings and get up a head of steam. She was just getting underway when the first of the Confederate vessels, the *General Bragg*, struck her abreast her magazine. The impact tore a large hole in the *Cincinnati's* hull. Unable to maneuver, she was struck two more times in succession, by the *General Sterling Price* and the *General Sumter*. In the process she was holed so badly that she sank. The three Confederate vessels did not escape damage. While the *Cincinnati* lacked the ability to maneuver to avoid the Rebel rams, her guncrews were nevertheless able to deliver several accurate broadsides on the Confederates, disabling all three vessels. Alerted by the sound of the *Cincinnati's* gunfire, the rest of the Federal flotilla made its way downriver under a full head of steam. They literally ran head-on into the remaining five Confederate rams. The *Mound City*, unable to maneuver quickly enough to avoid collision, was struck by the *General Van Dorn* and holed so badly in her bow that she had to be run onto a shoal to avoid sinking.

Like those of the *Cincinnati*, the rest of the flotilla's guncrews were able to deliver a withering fire on the cotton armored rams. Two more of the vessels, the *Van Dorn* and the *General Lowell* were disabled before the rest of the Confederate flotilla retreated downriver, to a safe anchorage under the guns of Fort Pillow.[49]

In one of the few ship-to-ship engagements of the riverine war, the Federals suffered a defeat which highlighted the vulnerability caused by the poor maneuverability of the vessels of the Western Gunboat Flotilla. The swifter Confederate rams were able to sink two City-class ironclads before being forced to disengage. Federal cannonfire, although ultimately disabling five of the Confederate vessels, could not prevent the rams from accomplishing their mission. Most of

the flotilla's fire, while devastating to the Rebel crews, passed right through the lightly constructed superstructures of the Defense Fleet's vessels.

It was not until June 6, at the Battle of Memphis, that Charles Ellet's United States Army Mississippi Ram Fleet was able to bring about the demise of the Confederate vessels. Although better constructed than the Confederate rams, Ellet's fleet was just as fast and maneuverable. Fighting in the van of the Western Gunboat Flotilla, the rams disabled most of the Confederate vessels, making them easy targets for the ironclads' heavy batteries which ultimately destroyed all but one of the Rebel rams.

The initial trials by combat of the flotilla revealed nearly disastrous flaws in gunboat design: the almost complete lack of topside armor made the vessels exceptionally vulnerable to plunging fire; all the ironclads were grossly underpowered and difficult to maneuver; and powerplants in all the flotilla's vessels were exceptionally vulnerable, especially to plunging fire. The positioning of steam drums on gundecks put gun crews at risk from scalding steam. On top of all their other flaws, the vessels had inadequate watertight divisions. Once the vessels were holed by enemy fire, this flaw hampered damage control efforts aimed at keeping them afloat.

These weaknesses and more were discovered during the first year of the Western Gunboat Flotilla's existence. A final test of the organization's ability to adapt old, and construct new vessels to better meet the conditions faced during that year can be found in the performance of the follow-on classes of riverine warcraft launched after the flotilla's first battles.

CHAPTER 4

FOLLOW-ON VESSELS AND SUBSEQUENT ACTIONS

Throughout the war, the Department of the Navy recognized the unique nature of the riverine environment and let contracts for the construction of vessels specifically designed to operate on the rivers of the Mississippi basin. The City-class ironclads were the first example of purpose-built riverine war vessels. One or more of these vessels were present at every major Civil War action fought on the waters of the Mississippi basin. The early trials of the class, fought at Henry, Donelson and Island Number 10, were over by the end of the first week of April 1862. That same month, a Navy board awarded contracts to four builders for the construction of eight additional purpose-built vessels to carry out the Federal campaign on the Western waters.

Two of the vessels, the *Marietta* and the *Sandusky*, were designed with iron hulls. Due to various difficulties with contract specification changes and ensuing alterations, these vessels were not delivered to the Navy until May 1866; too late to participate in the war. Of the remaining vessels, three were casemate ironclads and three more were constructed with turrets. The board from the Bureau of Yards and Docks which reported on contractor proposals and submitted contract recommendations had only two criteria which those proposals had to meet: the proposed vessels had to draw between three and five feet, and forward firepower had to be emphasized.[1]

None of the sources available to the author specifically state that this second group of vessels was built with the painful lessons of the early battles of the Western waters campaign in mind. However, one can infer from the design characteristics of these vessels that the lessons learned were applied in follow-on purpose-built ironclad construction.

The purpose of this chapter is to examine these follow-on vessels and evaluate the degree to which their construction and subsequent performance addressed design weaknesses revealed in previous vessels by the test of combat

Joseph Brown's Ironclads

One of the four companies receiving contracts from the Navy was the firm of Joseph Brown of Cincinnati, Ohio. Brown's vessels, although built under a single contract and with the same design concept, are not refered to as a class. This is because there were significant differences in the actual dimensions and construction of the hulls. Brown's contract called for the construction of three casemated river ironclads. His concept for the vessels involved the construction of a "wide riverboat hull with only paddleboxes, funnels, and casemate above deck."[2] The casemate was unique among previously constructed vessels in that it was oriented athwartships. The proportionally wide hull dimensions facilitated the mounting of heavy guns to fire through ports pierced in the forward face of the casemate. Two of Brown's vessels mounted two guns forward and the third, three.

Another innovation introduced in Brown's vessels was a hybrid propulsion plant. Two of his vessels were so equipped. The plant was designed with two sidewheels and two screw propellors, all independantly controllable. In view of the excessively wide dimensions of Brown's vessels, the size and variety in the machinery of the propulsion system may have been more an attempt to improve maneuverability than to increase speed. This assertion is supported by the fact that the contract only called for the vessels to be able to make four knots against a two mile per hour current. Excess speed, so closely related to maneuverability in naval vessels, was not a characteristic of the first generation of riverine ironclads.

Several sources suggest that the absence of a greater speed requirement in vessels contracted after the City-class saw first combat was intentional. These vessels were intended

primarily to support Army operations. It is generally accepted that Civil War era infantry could march approximately fifteen miles per day. Therefore, there was no real operational requirement for speed in order for the flotilla's vessels to be able to keep up with the pace at which the Army advanced. In addition, the tactics employed by the Federal Navy commanders in the theater deemphasized the tactical advantage of speed and maneuverability in battle. By attacking bows on, into the current, the vessels of the flotilla became near stationary gun platforms, slugging it out with Confederate fortifications.

USS *Chillicothe*

The first of Brown's vessels was the USS *Chillicothe*. The *Chillicothe* was the shallowest draft purpose-built ironclad constructed for riverine use. The contract let to Brown's firm specified penalties for every inch of water she drew greater than her two feet, eleven inch specification. The contract also included a clause giving the government the option of rejecting the vessel if her draft exceeded three feet, four inches at delivery.[3] As completed the hull dimensions were 164 by 50 feet.

Earlier discussion has illustrated the inherent difficulty in maintaining sufficient hull rigidity when constructing a wooden hulled vessel of the dimensions typical of western river steamers. Recall that the City-class ironclads' original specification called for a nine foot depth of hold. Since there had been little improvement or change in construction materials, Brown's attempt at acheiving sufficient rigidity in his vessels' hulls was predicated on a unique interior structural design. A system of longitudinal bulkheads supported the hull fore and aft, while a series of arched, lattice athwartships bulkheads, braced diagonally, supported the vessel across the hull.[4]

The *Chillicothe* was constructed without conventional lateral deck beams or fore and aft planking on her main deck. That deck was constructed of eight-by-eight inch timbers laid side by

side laterally and bolted end to end. As a result, the main deck structure provided no longitudinal support for the vessel's hull. According to Canney, the resulting tendency for hogging in all Brown's vessels was phenominal. The *Chillicothe* was modified with bolts, braces and straps on numerous occasions in attempts to correct this design flaw.[5]

Predictably, the shallow, flexible hull and new powerplant resulted in a much faster vessel than the contract required. *Chillicothe* attained a speed of nine miles per hour going upstream during her trials. While there are numerous cases where lack of speed in the typical vessel of the Western Gunboat Flotilla is lamented, the author could find no instances where the greater speed of the *Chillicothe* and her "yard sisters" *Indianola* and *Tuscumbia* provided any significant tactical benefit. The reason for this omission is probably two-fold. First, since the rest of the ironclads in the Flotilla were dismally slow, as part of a tactical formation the three Brown-built vessels were limited to the speed of the formation's slowest vessel. Second, Brown's vessels were so poorly designed and constructed that nobody wanted to say anything good about them. On taking command of the *Chillicothe* in October 1862, Lieutenant Commander John Walker describes the condition of his vessel:

> I found the contractor at work on board putting a light hurricane deck over her and filling in her gunports, 9 inches on each side and 9 inches at the bottom.
>
> Her ports had been already cut out on the upper side 5 inches, so that about the ports both wood and iron is patched a good deal and therefore deficient in strength. This will, however, be protected a measure by the port shutters when in place. When underway she worked enough to open a seam a half inch or more all the way across the deck over the engines. The contractor is now trying to strengthen her by iron straps fore and aft under the deck and bolted through. She is a scow, without knees or anything to strengthen her and I think very weak. She leaks forward when underway about the plating bolts, and her decks leak very badly.
>
> The quarters for officers and men are small, badly ventilated, and extremely uncomfortable. Houses could be built on deck at very small expense, which could do much for the health and comfort of the officers of the vessel.
>
> The wheel is in the gun tower, between the two forward ports, and very much in the way of the guns in action, while the pilots can only see ahead, in a river, I take it, is a grave objection to the present position. A pilot house should be built abaft and joining the gun tower, with lookout holes in all directions.[6]

Difficulties with the position of the main armament would plague Brown's vessels throughout their brief service lives. Walker's letter suggests that it was extremely difficult to navigate the *Chillicothe* even when the guns were not being fired. If this is true, it must have been nearly impossible for the pilot and officer of the deck to con the vessel in combat with an 11-inch gun blasting away on either side of their station.

On paper, Brown's creations were better protected than the City-class ironclads. Their casemates were all constructed of solid nine inch pine, backing three inches of iron armor. Additionally, perhaps in response to early experience with plunging fire, the eight inch pine decks already described were overlaid with an inch of iron plating. At face value, this construction not only offered a substantial improvement in protective armor over that provided for by Eads in his vessels, but promised to answer vulnerabilities uncovered in the City-class during combat as well. Unfortunately, *Chillicothe's* first combat trial would reveal Brown's vessels for the dismal combatants they actually were.

That trial came in February 1863, when Generals Grant and Sherman, along with Rear Admiral David Dixon Porter executed an abortive operation to encircle Vicksburg from the north. The expedition was to utilize an abandoned barge canal, the Yazoo Pass, to get into the headwaters of the Yazoo River. Newspaper articles written by correspondents traveling with the Federal forces alerted Major General John Pemberton, the Confederate commander at Vicksburg, to the Federal plan. Pemberton put slaves and troops to work creating obstructions and building a cotton and earthwork fortification at Greenwood, Mississippi, near where the Tallahatchee and Yalobusha Rivers come together to form the Yazoo.

The Federals blasted away the Mississippi River levee that had closed the canal. After a week long wait for the water level in the canal to fill to equal levels with the Mississippi, the

Union squadron entered the passage. After fighting thier way past Confederate snipers and through their obstacles the Federals arrived at Fort Pemberton early in March of 1863.[7]

Twice involved in attacks on the fortifications there, the *Chillicothe* was badly battered. According to Lieutenant Commander Watson Smith, during the first action, "The enemy immediately opened fire, with apparently five guns, striking the Chillicothe repeatedly and seriously damaging the forward face of the casemate, starting the iron plates and bolts, and driving back the 9-inch, white pine backing."[8] Chillicothe's second attack was even more damaging to the vessel.

> In less than fifteen minutes the Chillicothe was rendered quite ineffectual by the port slide cover of the port front port being struck with a 68-pound shot, breaking through, though not passing through, and causing such elevations and depressions in the plates as to render it impossible to slide back the port covers for the purpose of running out the gun.
>
> At the same time the iron covering and surrounding the other port was similarly disarranged, preventing the working of that gun also. . . .
>
> The Chillicothe's powers of endurance were evidently unequal to the task of sustaining the fire of the guns used by the enemy.[9]

The *Chillicothe's* captain, Lieutenant Commander James Foster, was apparently a couragous man. His assessment, reported to Smith after completing hasty repairs following the second engagement, states: "The Chillicothe is now in condition to engage the enemy; she is, however, badly battered and shattered, and does not withstand the enemy's shot and shell as well as expected."[10] In a report dated two days later, detailing the damage inflicted on his vessel, Foster comments on one of the principal weaknesses in the Chillicothe's armor arrangement: "I would remark in passing that many of the armor bolts are very weak and imperfect spikes, with large heads (of which I send you a sample), and it is astonishing that the weight of the armor has not heretofore forced them out."[11]

It appears as if the mounting bolts were of such inferior quality that the vessel's commander was concerned that his armor was going to fall off by virtue of its own weight. His

confidence in the casemate's capability to protect its inhabitants while under enemy fire must have been low indeed.

Even when the iron resisted penetration, it is obvious from the accounts that the soft pine backing stove in as a result of projectile impact. In doing so it deformed the backing of adjacent armor plates. The "very weak" mounting hardware of the adjacent armor subsequently pulled loose from its backing, causing the "disarrangement" of the iron plate Smith described. In the process its deformation jammed the *Chillicothe's* gunport shutters closed.

A secondary consequence of the use of substandard hardware in mounting armor was the creation of a severe missile hazard to the vessel's crew. To quote Rear Admiral Porter in his report on the action at Greenwood: "The Chillicothe, from all accounts, has proven herself unfit to engage a battery, the bolts confining the iron to the ship having been found very destructive to those on board. The Chillicothe has suffered a good deal in killed and wounded . . ."[12]

In some cases four-inch drift (lag) bolts were used to secure three-inch-thick iron to soft pine backing. The impact of heavy shells sheared the heads off bolts and sent metal shrapnel flying through the casemate, shortening the life expectancy of its inhabitants.

While its utility when used as the sole material backing iron armor was suspect, pine had its uses in ironclad construction. It was used to line the pilot houses of the City-class vessels. Recall that these structures had between 12 and 19½ inches of layered oak backing iron armor. The soft pine lining was intended to absorb splinters knocked loose from the harder oak timbers by projectile impact. However, as the sole material in use backing iron armor, it was found wanting. During the same engagement which damaged the *Chillicothe* so badly, the USS *DeKalb*, one of the City-class ironclads, was under fire for a longer period and "recieved no damage of any consequence."[13]

USS *Tuscumbia*

The second of Brown's vessels was the USS *Tuscumbia*. At the time of her construction she had the widest beam of any vessel built for service in the United States Navy. Her exceptionally wide dimensions (176 by 72 feet) accomodated a sixty-two foot wide casemate designed to house three 11-inch Dahlgren guns. This was the heaviest (in terms of weight of projectiles per broadside) forward battery ever mounted on a river steamer. The *Tuscumbia's* armor protection and machinery were very similar to those of the *Chillicothe*. Late in her construction, and over the objections of the contractor, Rear Admiral Porter had a second casemate constructed on her stern. The aft casemate mounted two 9-inch Dahlgrens.

The *Tuscumbia* carried a total of 480 tons of iron armor. That weight was 358 tons, or about three times greater than that carried by the City-class vessels. The additional casemate, mounted as it was on a hull already structurally weak both longitudinally and athwartships, put tremendous stain on the vessel's hull. To counter the vessel's tendency to sag at her ends, the vessel had hog chains which had to pass over twenty foot high vertical stanchions in order to obtain sufficient leverage to carry their weight.[14]

During an April 29, 1863, action against Confederate fortifications at Grand Gulf, Mississippi, the *Tuscumbia* was struck eighty-one times by the elevated batteries at the site. The vessel's exposed hog chains were badly damaged. Of the four main fore and aft braces, three were shot away along with two of the athwartship braces and three deck braces attached to a bridgetree over the engines. This damage caused the vessel's ends to sag 7½ inches aft and 1½ inches forward. The bridgetree was one of two supporting the deck above the boilers. With three of its braces shot away and no beams or carlines to provide support, the deck sagged onto the boilers.[15]

The bridgetrees and chains supporting the vessel's paddlewheels were also almost entirely shot away.[16] As a result, the port wheel dropped and jammed itself against the vessel's hull.[17] Due to her great weight of armor and broad-beamed construction, the *Tuscumbia* relied on having all four sets of propulsion machinery on line in order to maneuver and maintain steerage. After losing only a single wheel, she was unable to stem the current and drifted out of control and out of the fight.

All the Brown vessels suffered this weakness. Because they were designed with excessively wide dimensions and flat bottom hulls, the process of mounting these vessel's sidewheels at deck edge resulted in the generation of a considerable moment when operating the wheels independently. This facilitated the use of the propulsion plant for maneuvering. Unfortunately, with the loss of one of the wheels, the yaw induced by the wheel acting on a long moment arm could cause the vessel to spin out of control. When the wheels of the *Tuscumbia* and *Indianola* were not used, their propellers alone normally did not supply sufficient thrust to stem a river's current. The *Chillicothe* was especially susceptible because she was the only one of Brown's vessels without a four engine powerplant (wheels only).

The *Tuscumbia* suffered the same deficiency with her armor mounting hardware as the *Chillicothe*. Like the *Chillicothe*, some of the drift bolts securing her armor plates were less than four inches long. The heavy pounding she took at Grand Gulf knocked a considerable number of her plates loose (one was completely dislodged and fell overboard) and smashed the soft pine backing the armor.[18]

Tuscumbia had two other weaknesses not mentioned in reference to either the *Chillicothe* or the *Indianola*. First, the casemate hatch leading to the magazine and shell room was located immediately abaft the center cannon and in direct line of what is described as an "excessively large gunport."[19] Apparently the crew were fatalistic about the prospect of an enemy shell coming

through the port, down the hatch into the shell room and killing them all. The second unique weakness of the *Tuscumbia* lay in her pilot house. It was a vertical structure made of two-inch oak; hardly sufficient to protect the pilot and officer of the deck in a vessel which sustained eighty-one hits in a single engagement.

USS *Indianola*

The last vessel constructed by Brown's firm was the USS *Indianola*. She was quite similar in size and layout to the *Chillicothe*. The primary difference between the two vessels was that the *Indianola* had two wheels and two screws rather than the paddlewheels-only propulsion machinery of the *Chillicothe*.

The *Indianola*'s combat service was short and undistinguished. In mid-Febuary of 1863 the vessel successfully ran the batteries at Vicksburg. Its mission in doing so was to take up station blockading the mouth of the Red River. On February 24, in a single action, she was attacked and rammed a total of seven times by the Confederate rams *Dr. Beatty, Queen of the West, Webb* and *Grand Era*. Because her heavy 11-inch and 9-inch Dahlgrens were poorly positioned to fire in any direction except fore and aft and because they had such a slow rate of fire, the *Indianola* was unable to fight off her faster, more agile antagonists. She was so badly damaged that she sank.[20]

Brown's casemated ironclads are universally considered to be pitiful fighting vessels. Although carrying twice the propulsion machinery and three times the protective armor of the City-class ironclads, they sustained terrific damage during their short combat service. *Indianola* fought in only one engagement and the *Tuscumbia* only one campaign; while the *Chillicothe* fought on the White River, and in the Vicksburg and Red River campaigns during her service with the Mississippi Squadron. While their crews fought well, they were severely handicapped by the flawed design and shoddy construction of their vessels.

Late Steamer Conversion Ironclads

About the same time Brown was building his ironclads, a Federal Navy officer was commited to an aquisition program of his own. Captain W. D. Porter, Rear Admiral D. D. Porter's estranged brother, evidently considered himself something of an expert on the construction of riverine war vessels. He directed the conversion of two river steamers which became the ironclads *Lafayette* and *Choctaw*. These vessels were unusual in two respects: their great size; and the composition of their armor.

USS *Lafayette*

The *Lafayette* was converted from the steamer *Alick Scott*. Before conversion the *Scott* had an overall length of 292 feet with a 44-foot beam. During her conversion Porter had her stripped to the main deck. After compartmentalizing the hull below the waterline, he had a full-length casemate constructed. The wooden bulwarks were thirty inches thick on the ends and twenty-one inches thick on the sides. Over the wooden structure Porter ordered constructors to lay a two-inch-thick layer of india rubber (gutta percha), over which they placed the vessel's 2½-inch iron armor. Porter claimed the combination provided the same protection as five inches of iron. On the other hand, his brother the admiral believed the configuration to be useless, contributing only to rot in the backing of the armor.[21]

Carrying eight heavy guns and equipped with an iron ram, the *Lafayette's* total length was over 300 feet. As might be expected, the great weight of iron, mounted on a conventional riverboat hull with a conventional Western riverboat powerplant, resulted in a dismally slow vessel.

Her "composite" armor did not afford the protection "Dirty Bill" Porter promised. During the bombardment of Grand Gulf she was struck seventeen times, five of which penetrated the iron casemate.[22] None of these shots did any serious damage. Canney speculates that the great

size of the vessel not only made her a big target but also served to spread out her vital machinery. In doing so, it decreased the likelihood of a single shot disabling her.

USS *Choctaw*

The *Choctaw's* size, layout and armor were similar to that of the *Lafayette*. The principal difference between the two vessels was the casemate. The *Choctaw's* was smaller and squarish, mounting roughly the same number of heavy guns in a more confined gundeck. The most notable weakness of the *Choctaw* was her dismally slow speed. Despite efforts made by Admiral Porter to have some of her "nonessential" iron removed she made only two knots against the current.

During an action at Drumgould's Bluff (Mississippi), she was struck forty-six times and penetrated on several occasions. Like the *Lafayette* at Grand Gulf, nothing vital was hit.
The *Lafayette* and the *Choctaw* were similar in many ways to two early conversion ironclad vessels; the *Essex* and the *Benton*. These four vessels were the largest and most heavily armored of the riverine war vessels. Like their two predecessors, the greatest weakness of the *Lafayette* and the *Choctaw* was their lack of speed and maneuverability. This fault limited their utility under circumstances where faster currents and narrower waters were encountered. In addition, their draft was somewhat deeper than their City-class and Brown-built cousins, making them unsuitable for use on some of the shallower rivers of the Mississippi basin during low-water stages. The vessel's armor was not impenetrable, but their size allowed vital machinery to be spread out, lessening the chances of a single shot disabling the craft. This characteristic alone must have made them popular with their crews.

Turret River Ironclads

The final catagory of vessels used for riverine operations on the waters of the Mississippi basin were the turret ironclads. The vessels should be distinguished from the monitors designed

by Ericsson and others for coastal use. Three vessels, two built by James Eads and one by George Bestor of Peoria, Illinois,[23] were the final purpose-built riverine ironclads to see combat during the Civil War.

USS *Osage* and USS *Neosho*

The two Eads vessels, the *Osage* and *Neosho*, were the "smallest and lightest draft ironclads of the war."[24] They were designed to operate on the shallowest of the basin's rivers and, armed with two heavy guns in a single turret, were constructed with a recessed paddlewheel to minimize the obstruction to the turret's field of fire. The vessel's deck was crowned and covered with 1½ inches of iron armor backed by only a 2 inch thickness of pine. Unlike the ill-conceived Brown vessels, the Eads turret ironclads were constructed with conventional deck beams. Other features included an auxillary engine to provide fan-forced draft for ventilation and a provision for forced draft to the firebox. Once launched it was discovered that these vessels drew less water than required by contract. As such, additional armor was added to the deck and around the boilers; improving their survivability. Eads' vessels were the only two paddlewheel turret ironclads of the war. Apparently, they were a success. Fast, when compared to their contemporaries, the *Osage*, at least, served with distinction at Blair's Landing, Louisiana during the Red River campaign.

The Red River campaign, conducted between March 12 and May 13, 1864, was the last major action of the Mississippi Squadron during the Civil War. The stated political objective of the campaign was to deter the French in Mexico from supporting Texas independence. To do this Lincoln sent a combined Army and Navy force up the Red River to occupy some portion of Texas. In reality the campaign was little more than a sanctioned cotton stealing expedition organized by a Union political general, Major General Nathaniel P. Banks. The principal lessons learned by the Navy commander, D. D. Porter, were never trust a political general and always

watch the stage of the Red River. Only a timely intervention by an ingenious Army engineer prevented virtually the entire Mississippi Squadron from being trapped by falling water.

It is not possible to fully evaluate the *Osage* and *Neosho* in the same light as the other vessels of the Mississippi Squadron. While they promised to be superior vessels, they never had to stand up under a pounding by heavy guns the way the City-class and Brown's ironclads did. They performed well during the Red River campaign but recieved only light artillery and rifle fire.

USS *Ozark*

Although it was common for the armor and machinery of period ironclads to be subcontracted by builders, George Bestor's design, the *Ozark*, was unique in that Bestor contracted out the entire vessel. She was armed and armored in a fashion similar to Eads' vessels, although her design was not as successful. A weak structure caused excessive "working" of the hull and engine frames. She was the only purpose-built riverine vessel constructed with quadruple screw propulsion. Her seven foot diameter propellers were mounted under a twelve foot long counter affording them considerably more protection than a wheel propulsion system. Unfortunately for the overall performance of the vessel, her machinery left a great deal to be desired. A system of mitered mortice gears connected the steam engines' cylinders to the propellers. These gears were made of wood and the whole installation was primitive, even by the standards of the day.[25]

Along with twin 11-inch Dahlgren guns mounted in the single Ericsson turret, the vessel boasted deck mounted heavy guns. These pieces were located on the *Ozark's* stern behind wooden bulwarks constructed to protect their gun crews. The added weight of guns and bulwarks aft threw the vessel out of trim, making her ride bow up. Admiral Porter characterized her as ungainly and unmanagable. He complained about the vessel's structural weaknesses and the fact that the coal consumption of her plant was excessive (at 2.1 tons per hour, more than a River-class

frigate).[26] At any rate the vessel's combat service was limited to the Red River campaign where, aside from participating, her performance was unremarkable. For the same reasons as for the *Osage* and *Neosho*, it is not possible to compare this vessel to the early ironclads.

Subsequent Tinclad Conversions

During the same period all the purpose-built vessels were being constructed, numerous river steamers were being converted into tinclads. These vessels served with distinction convoying transports, serving as transports and supporting the Army in general. However, most sources agree that these vessels were kept in the rear of the heavy ironclads during the "serious" fighting against Confederate river fortifications.

In general, the second generation of riverine ironclads brought their own set of weaknesses to the battlefield. In many cases the weaknesses of the first generation were repeated as well. It is apparent, that far from profiting from experience and observation, the designers of the second generation compounded the deficiencies uncovered in the first. These deficiencies, identified in the vessels analized in this study and revealed under the conditions described herein, form the basis for a conclusion as to the success of Northern naval constructors in creating vessels equal to the task of riverine warfare on the waters of the Mississippi basin.

CHAPTER 5

CONCLUSIONS

The purpose of this study was to determine the extent to which the design, construction and modification of the vessels of the Federal force's Western Gunboat Flotilla changed over the course of the Civil War. Of particular interest were changes made in response to the conditions the vessels and their crews encountered throughout the war and the degree of improvement in performance displayed by new vessels entering service with the flotilla after its initial baptism of fire. This degree of improvement indicates the extent to which Navy Department boards responded to operational and tactical requirements encountered during riverine combat on the waters of the Mississippi River basin. When looked at over time, observed improvement in the ability of the flotilla's vessels to stand up under the conditions they encountered is an indicator of a response from the Navy's design and construction bureaucracy to the special requirements of riverine warfare.

What the performance of the vessels in fact indicates, is that regardless of the overall success of the organization, the Department of the Navy failed in its obligation to provide a class of vessel which incorporated features ideally suited to the riverine environment.

As an organization, the Western Gunboat Flotilla performed very well in cooperating with the U.S. Army pioneering joint operations in the riverine environment. Commander John Rodgers' persistence and initiative in establishing the embryonic flotilla and Flag Officer Andrew Hull Foote's leadership and spirit of cooperation set standards in facilitating the adaptation of a peacetime organization to unanticipated requirements dictated by conflict. These officers, and

Flag Officer Charles Davis and Rear Admirals David Dixon Porter and S. P. Lee who followed, led an organization which accomplished its mission supporting the Federal advance into the Southern heartland. They were successful because they utilized the equipment at hand and readily available, adapting tactics and operational maneuver to the strengths and weaknesses discovered in that equipment. In many cases, while they recognized vulnerabilities, they lacked the capability to rectify them and simply accepted the fact and pressed on with their conduct of the war.

In view of the industrial base resident in the North, it is difficult to understand how Navy Department bureaucracy failed to establish a systematic approach toward improving the Western Gunboat Flotilla's vessels. There was undoubtedly a great deal of parochialism and blue water bias which influenced the flow of personnel and resources toward the blockade squadrons. However, neither this fact, nor the flotilla's early affiliation with the Department of War can be laid completely to blame for the lack of systematic improvement in design and construction which was so evident in the upgraded classes of coastal monitors.

The most likely explanations lie in the lack of institutional focus by the Department of the Navy on a distant theater and a certain cold-bloodedness on the part of the Federal bureaucracy toward the relatively insignificant casualties suffered by the Navy during the actions on the Mississippi River and her tributaries. Regardless of the fact that Navy casualties were partially caused by poorly designed equipment, to an administration accustomed to receiving reports of Army dead and wounded numbering in the thousands, the loss of a few tens of sailors and the necessity for some relatively cheap patchwork to their vessels must have constituted good news. Therefore, the impetus for establishing a program for short-term upgrade and long-term improvement must have been minimal. Proof of the lack of Navy Department interest in developing a permanent riverine capability lies in the fact that the bulk of the Mississippi Squadron was sold off at a Mound City auction on November 29, 1865; just four months after the

war's end. The Navy had no interest in maintaining its riverine capability beyond the immediate Civil War requirement.

During the war, criteria established for riverine design submissions emphasized draft and foward firepower, not survivability. The two former criteria were a response to geography, river current and the tactics developed to offset technical deficiencies in existing vessels. They were not a result of vulnerabilities discovered in combat.

The evidence indicates that the greatest single vulnerability of the flotilla's vessels was their susceptibility to plunging fire. The City-class ironclads had no deck armor whatsoever. The damage they sustained from bluff-mounted gun batteries resulted in every vessel of the class being disabled by enemy fire at one time or another during the war. Some follow-on vessels, notably Joseph Brown and James Eads constructions, incorporated deck armor. However, the effectiveness of their thin plating was minimal. In the case of Brown's vessels, the marginal protection afforded by thin, one-inch-thick iron was made even less effective by inadequate structural design and construction backing the armor.

The root of the problem of poor combat performance is found in the level of sophistication in material and construction technology available at the time of the Civil War. The vessels of the Western Gunboat Flotilla were all wooden framed and hulled. The dimensions and draft required of the vessels precluded mounting iron in quantity and thickness sufficient to better resist penetration. Wood was simply too weak a structural building material to carry sufficient weight over a span of the dimensions of these vessels, given the shallow depth of hold required. Part of the problem with structural weakness found in riverine ironclad hulls may have been alleviated by the use of iron in their construction. The *Marietta* and *Sandusky* were the first iron-hulled riverine purpose-built vessels. Unfortunately they were delivered too late to see Civil War service.

The other great weakness, lack of speed and maneuverability, also had its roots in primitive technology. The typical 600 horsepower powerplant of the day was sufficient to push the standard river steamer upriver at speeds of about ten knots. The same plant in a heavy ironclad could not come close to matching this speed, at least not in the vessels which bore the brunt of the flotilla's combat service. The Navy mindset of only requiring sufficient speed to stem a river current and to keep up with the advancing Army stifled innovation in improving powerplant technology. Very shortly after the war, higher pressure steam plants and multiple-expansion engines would greatly increase the horsepower available in steamships. Walke's vessels demonstrated the value of speed and maneuverability in avoiding cannonfire during the action at Belmont and the vulnerability of ironclads to swift, maneuverable rams is sufficiently demonstrated in the actions around Memphis and in the *Indianola's* demise at the mouth of the Red River. It is therefore reasonable to assume that the incorporation of a more powerful propulsion plant into existing vessel classes may have changed the tactics used to fight the battles of the Western waters campaign.

Poor design, poor construction, geography, hydrography and primitive technology all combined to limit the individual performance of the riverine vessels of the Western Gunboat Flotilla. The organization's success in supporting Grant's Army Department of the Tennessee was more a matter of persistence on the part of the Federals than one of excellence and technical superiority in the equipment the Navy contributed to the fray.

Today, naval vessels are upgraded by class, utilizing a system of block modifications. This allows the service to incrementally improve the combat capability of whole classes of vessels. While primarily an economic measure, this practice allows the Naval service to float vessels which are designed to be upgraded. In this manner, the Navy can keep pace with advances in technology and changing capability requirements dictated by the political and strategic

environment. Unfortunately, the pace of modern war is increasing while the process of funding and fielding block modifications remains a lengthy one. As shown, during the Civil War, over a period of just ten months, the Navy went from no riverine force whatsoever to floating the credible flotilla which assaulted Fort Henry. To put this in perspective, Operation DESERT STORM was fought in just under four months. It is obvious that the tempo of modern military operations promises to make vessel upgrades, undertaken in response to combat lessons learned, something which will always benefit the organization in the next conflict, not the one at hand.

There are several lessons which military organizations today can take away from the Civil War experiences of the Western Gunboat Flotilla. First of all, Rodgers and Pook clearly recognized at least some of the weaknesses of the early ironclads before those vessels ever saw combat. Pook's design, used in the first purpose-built ironclad vessel contracted for by Rodgers, was presumably the best compromise between the conditions he anticipated the vessels encountering and available construction techniques and technology. Compromise was nothing new in naval construction, even during the Civil War era. It is still very much a part of the design of today's vessels. As an example, major changes were made in the specifications for the latter ships of the *Oliver Hazard Perry* class of guided-missile frigate. The changes were a result of a disastrous lesson learned by the British during the Falkland Islands war in the early 1980's. The British used aluminum in the construction of the superstructures on their County-class frigates. The use of aluminum improved stability and ultimately saved money during construction and operation. However, it burned easily and it provided little protection against Argentine bombs and anti-ship missiles. Both of the weaknesses were known and the risks inherent in the use of aluminum accepted as a compromise. It is generally accepted that the loss of life resulting from missile hits to the superstructures of County-class vessels could have been minimized had steel been used in their construction.

Today, as an economic compromise, the early flights of the *Arleigh Burke*-class of guided-missile destroyers are being constructed without helicopter hangars. The lack of this facility may affect the performance of the early vessels of the class is some future conflict. Similar compromises have occurred in naval construction throughout history and will continue to be made. The important lesson to learn is: those weaknesses which have the potential to be disastrous (boiler position, steam drum vulnerability, and lack of overhead armor) must not be compromised and must be designed out of a vessel before its introduction into service.

Second, the constraints of the physical environment of the battlefield do more to affect the performance of a vessel than any other single factor. During the Civil War, design and construction of the vessels of the Western Gunboat Flotilla were dictated by the environment of the Mississippi River basin. Today, in its role as a global instrument of United States policy, the Navy finds itself operating in a variety of different environments. It must be wary of constructing vessels which are optimized for use in a single environment; especially when the high cost of ship construction limits the number of different types of vessel available. Failure to do so promises to leave any military service in a situation similar to that encountered by Gideon Welles in 1861, when he found that his Navy had no vessels capable of riverine warfare on the Western waters.

Finally, the wartime expedient of simultaneously letting contracts for the construction of vessels of different designs to different contractors can result in repeated design flaws. During the Civil War, there was no single class of vessel where solutions to operational weaknesses were identified and designed out of improved vessels of the same class. The City-class ironclads saw more combat than any other purpose-built vessel class constructed during the war. Where their vulnerabilities to plunging fire and lack of maneuverability could have been lessened by design improvements in a latter run of vessels of the same class, the class's primary contractor abandoned the design in favor of a new type of turret river ironclad. Thus, the hard-earned benefit of lessons

learned in combat, and recognized flaws in the City-class were lost. The process of identifying flaws and applying field expedient measures to compensate for them had to begin anew. The resulting poor performance of vessels such as the *Chillicothe, Tuscumbia,* and *Indianola* was the inevitable result.

During the Civil War, innovations like the turret, screw propeller and others were in their infancy. Technical problems associated with their introduction were often as disabling as any enemy cannon fire. The same holds true for the status of improvements in construction and material technology. During the 1860s, naval constructors were apparently at a crossroads where imagination with respect to conceptual vessel design, available construction capacity, and wartime requirement just barely outstripped the state of the art in materials and actual structural design capability. The result was a flotilla whose vessels did not quite work as advertized.

This last lesson, learned as a result of the performance of riverine vessels in a nineteenth century war, is perhaps the most important one United States military services can apply when conceiving of, designing, and building the hardware for its twenty-first century force. The process by which imagination outstrips the state of the art in technology is a cyclical one. The innovations introduced in America during the Civil War were perfected once technology caught up with concept. Likewise, the unknown problems which come with new technology and are discovered during service introduction, are eventually designed out of today's systems.

The United States military services today stand at a crossroads similar to the one faced by the Federal military during the Civil War; one where a balance must be attained between what is conceivable and what is achievable In order to keep pace with the high tech demands of future warfare, today's services must allow for the accelerating rate of change in the state of the art in technology as they conceive of their twenty-first century weapons. At the same time, they must create and maintain an institutional capability to adapt hardware and doctrine to the level of

technology presently achievable. Without this balance, like the Federal forces of the Civil War, today's military organizations may find themselves with weapons which do not quite work as advertized. The political and military consequences of an institutional failure to provide soldiers, sailors, airmen and marines with suitable equipment, in an era were media coverage subjects their every action to intense scrutiny, is potentially devastating.

APPENDIX A

FINAL REPORT OF MISSISSIPPI SQUADRON COMMANDER ON THE DISPOSITION OF HIS VESSELS

The final report of Rear Admiral S. P. Lee concerning the disposition of the vessels of the Mississippi Squadron, taken from the *Official Records of the Union and Confederate Navies in the War of the Rebellion, vol. 27*, is included to give the reader an indication of the size of the organization and the scope of its deployment when it reached its zenith in 1865.

Report of Acting Rear-Admiral S. P. Lee, U. S. Navy, Showing the disposition of vessels of his command

FLAGSHIP TEMPEST,
Mouth White River, May 1,1865.

Sir: The following is the present disposition of the vessels of this squadron:

Name of Vessel	Number of Guns	Commanding Officer
*Tempest, flagship	8	Acting Volunteer Lieutenant W. G. Saltonstall

First District, New Orleans to Donaldsonville, 75 miles, Lieutenant-Commander W. E. Fitzhugh, commanding

Name of Vessel	Number of Guns	Commanding Officer
*Ouachita	39	Lieutenant-Commander W. E. Fitzhugh
*Alexandria	2	Acting Master D. P. Rosenmiller
*Argosy	9	Acting Master J. C. Morong

Second District, Donaldsonville to Morganza, 100 miles, Lieutenant-Commander J. J. Cornwell, commanding

Name of Vessel	Number of Guns	Commanding Officer
Choctaw	8	Lieutenant-Commander J. J. Cornwell
*General Price	4	Acting Volunteer Lieutenant W. R. Wells

*Nymph	8	Acting Master P. Donnelly
*Naiad	7	Acting Master H. T. Keene
*Ivy, tug		Acting Ensign Perry C. Wright

Third District, Morganza to Red River, 25 miles, Lieutenant-Commander E. C. Grafton, commanding

Name of Vessel	Number of Guns	Commanding Officer
Manhattan	2	Lieutenant-Commander E. C. Grafton
Tennessee	6	Lieutenant-Commander E. P. Lull
*Fort Hindman	8	Acting Volunteer Lieutenant Jno. Pearce
*Gazelle	6	Acting Master W. T. Powers
*Silver Lake	6	Acting Master J. C. Coyle
Collier	9	Acting Master J. F. Reed
Hyacinth, tug		Acting Ensign J. B. Hiserman
*Dahlia, tug		

Fourth District, Red River to Natchez, 70 miles, Lieutenant-Commander J. P. Foster, commanding

Name of Vessel	Number of Guns	Commanding Officer
Lafayette	9	Lieutenant-Commander J. P. Foster
*Chillicothe	3	Acting Volunteer Lieutenant George P. Lord
*Kenwood	7	Acting Volunteer Lieutenant Jno. Swaney
*General Bragg	3	Acting Volunteer Lieutenant C. Dominy
Neosho	2	Acting Volunteer Lieutenant Saml. Howard
*Peri	8	Acting Master Thos. M. Ferrell
*Champion	5	Acting Ensign Thos. Devine
*Little Rebel	4	Acting Ensign J. B. Petty

Fifth District, Natchez to Vicksburg, 125 miles, Lieutenant-Commander E. Y. McCauley, commanding

Name of Vessel	Number of Guns	Commanding Officer
*Benton	13	Lieutenant-Commander E. Y. Mc Cauley

*Avenger	7	Acting Volunteer Lieutenant Charles A. Wright
*Forest Rose	8	Acting Volunteer Lieutenant A. N. Gould
*Mound City	9	Acting Volunteer Lieutenant G. W. D. Patterson
*Lexington	10	Acting Volunteer Lieutenant William Flye
*Springfield	12	Acting Master Edm. Morgan
*Gamage	9	Acting Master William Neil
*Oriole	9	Acting Master Edward Alford
*Romeo	6	Acting Master Thomas Baldwin
*Naumkeag	7	Acting Master A. F. Thompson
*Fern, tug		Acting Ensign John M. Kelly

Sixth District, Vicksburg to Arkansas River, 210 miles, Lieutenant-Commander George Bacon, commanding

Name of Vessel	Number of Guns	Commanding Officer
*Louisville	7	Lieutenant-Commander George Bacon
*Ibex	8	Lieutenant-Commander R. L. May
*Vindicator	13	Acting Volunteer Lieutenant-Commander W.R. Hoel
*Juliet	6	Acting Volunteer Lieutenant T. B. Gregory
*Tyler	14	Acting Volunteer Lieutenant Frederick S. Hill
*Ozark	7	Acting Master John Powell
*Brilliant	6	Acting Master J. H. Rice
*Colossus	7	Acting Master F. G. Sampson
*Mamora	8	Acting Master Thomas Gibson
*Kate	9	Acting Master Thomas Burns
*Victory	6	Acting Master N. B. Willits
*Laurel, tug		Acting Ensign W. R. Owens

Seventh District, Arkansas River to Memphis, 190 miles, Lieutenant-Commander J. G. Mitchell, commanding.

Name of Vessel	Number of Guns	Commanding Officer
*Grossbeak	8	Acting Volunteer Lieutenant J. W. Atkinson

*Exchange	7	Acting Volunteer Lieutenant J. C. Gipson
*Fawn	8	Acting Master John R. Grace
*Cricket	7	Acting Master M. J. Cronin
*Silver Cloud	7	Acting Master W. Ferguson

Eighth District, Memphis to Mound City, 260 miles, Commander A. Bryson, commanding

Name of Vessel	Number of Guns	Commanding Officer
*Fairy	8	Acting Volunteer Lieutenant F. S. Wells
*Essex	12	Acting Volunteer Lieutenant John C. Parker
*Hastings	9	Acting Volunteer Lieutenant J. [S.] Watson
*Huntress	6	Acting Master H. E. Bartlett
*Mist	7	Acting Master W. E. H. Fentress
*Siren	8	Acting Master James Fitzpatrick
*Robb	4	Acting Ensign James Tuohy

Ninth District, Mound City to Mussel Shoals, Tennessee River, Lieutenant-Commander R. Boyd, Jr., commanding.

Name of Vessel	Number of Guns	Commanding Officer
*Peosta	15	Acting Volunteer Lieutenant T. A. Harris
*Carondelet	7	Acting Volunteer Lieutenant John Rogers
*St. Clair	6	Acting Volunteer Lieutenant J. A. French
*Paw Paw	8	Acting Master M. V. B. Haines
*Fairplay	8	Acting Master G. J. Groves
*Tensas	2	Second-class Pilot E. C. Van Pelt

Tenth District, Cumberland River and upper Ohio, Lieutenant-Commander Le Roy Fitch, commanding

Name of Vessel	Number of Guns	Commanding Officer
*Moose	10	Lieutenant-Commander Le Roy Fitch
*Abeona	9	Acting Master Samuel Hall

Eleventh District, above Mussel Shoals, Tennessee River, Lieutenant Moreau Forrest, commanding

Name of Vessel	Number of Guns	Commanding Officer
General Burnside	5	Lieutenant Moreau Forrest
General Grant	5	Acting Master Jos. Watson
General Sherman	5	Acting Master J. W. Morehead
General Thomas	5	Acting Master Gilbert Morton

Recieving Ship

Name of Vessel	Number of Guns	Commanding Officer
Grampus		Acting Ensign G. W. Litherbury

On special duty

Name of Vessel	Number of Guns	Commanding Officer
*Curlew	8	Acting Master M. Hickey

Transports, dispatch boats, etc., headquarters, Mound City

Name of Vessel	Number of Guns	Commanding Officer
*General Pillow, guard boat to magazine boat	2	Acting Ensign F. W. Halsted
*Red Rover, hospital	1	Acting Ensign Charles King
*Genl. Lyon, dispatch and supply vessel	3	First-class Pilot R. E. Birch
Brown	2	First-class Pilot J[efferson] A. French
*Reindeer, dispatch and supply vessel	8	Acting Ensign J. M. Farmer

Vessels repairing and fitting at navy yard, Mound City

Name of Vessel	Number of Guns	Commanding Officer
*New Era	6	Acting Master A. C. Sears
*Prairie Bird	8	Acting Master Thomas McElroy
*Pittsburg	8	Acting Volunteer Lieutenant Edward Morgan

*Tuscumbia, dismantled		
*Indianola, dismantled		
*Judge Torrence	2	Acting Master J. Irwin
*Daisy, tug		Mate J. Graham
*Thistle,tug		Acting Ensign R. J. Eltringham
*Myrtle, tug		Acting Ensign I. N. Goldsmith
*Sibyl		Acting Master C. Swendson
*Samson		

I have the honor to be, sir, very respectfully, yours,

S. P. Lee,

Acting Rear-Admiral, Commanding Mississippi Squadron

Hon. Gideon Welles,
Secretary of the Navy, Washington, D. C.

Note: * indicates vessel sold at auction at Mound City, Illinois, November 29, 1865

APPENDIX B

DISPOSITION OF OTHER WESTERN GUNBOAT FLOTILLA VESSELS

Vessel	Type	Commissioning Date	Disposition
Cairo	City-class ironclad	January 25, 1862	Sunk by mine, December 12, 1862
Baron DeKalb	City-class ironclad	January 31, 1862	Sunk by mine, July 13, 1863
Osage	Eads Turret ironclad	July 10, 1863	Sunk by mine, March 29, 1865

APPENDIX C

WESTERN WATERS THEATER OF OPERATIONS

Source: Ivan Musicant, *Divided Waters* (New York: HarperCollins, 1995), 273.

ENDNOTES

Chapter 1

[1]Ivan Musicant, *Divided Waters* (New York: HarperCollins Publishers, 1995), 6-27.

[2]Charles B. Boynton, *History of the Navy During the Rebellion* (New York: D. Appleton and Company, 1867), 75-82.

[3]Donald L. Canney, *The Old Steam Navy*, vol. 1, *The Ironclads, 1842-1885* (Annapolis: Naval Institute Press, 1993), 15.

[4]Boynton, *History of the Navy During the Rebellion*, 95-106.

[5]Ibid.

[6]Musicant, *Divided Waters*, 52-53.

[7]Theodore Ropp, "Anacondas Anyone?" *Military Affairs 27* (Summer 1963), 72-76.

[8]*Official Records of the Union and Confederate Navies in the War of the Rebellion,* vol. 22 (Washington, DC: Government Printing Office, 1894-1922), 280.

[9]Ibid., 284-285.

[10]Ibid., 286.

[11]Ibid.

[12]Richard S. West, Jr., *Mr. Lincoln's Navy* (Westport, CT: Greenwood Press, 1957), 161.

[13]Ibid., 320.

[14]Foote's command and control difficulties are described in several sources. The author used West's *Mr. Lincoln's Navy*, Musicant's *Divided Waters*, and Coombe's *Thunder Along the Mississppi* in researching his own description.

[15]Mark Twain, *Life on the Mississippi* (New York: Harper and Row Publishers, 1951), Chapter 15.

[16]Ibid.

[17]James M. Merrill, "Cairo, Illinois: Strategic Civil War River Port," *Journal of the Illinois State Historical Society*, Winter 1983, 242-247.

Chapter 2

[1]The MV *Robert E. Lee* circa 1870.

[2]James B. Eads made his first fortune in this business.

[3]Twain, *Life on the Mississippi*, 149-152.

[4]Canney, *The Old Steam Navy*, 35.

[5]United States Army Corps of Engineers, Memphis District, *Cultural Resources Investigations and Assessment of the Mound City Shipyard and Marine Ways (11 PU 140), Pulaski County, Illinois* Final Report, 17 October, 1986 (New Orleans: R. Christopher Goodwin and Associates, 1986), 112-113.

[6]*Official Records of the Union and Confederate Navies in the War of the Rebellion,* vol. 22, 318.

[7]Some sources use the name *Tyler* or *A.O. Tyler* for this vessel. Commander Henry Walke was one of the first Navy commanders of the vessel. He called her the *Taylor,* so that name will be used throughout the text.

[8]*Official Records of the Union and Confederate Navies in the War of the Rebellion,* vol. 22, 283.

[9]Ibid., 319.

[10]Dohrman, "Old Man River, 1863," 809.

[11]Frederic S. Hill, *Twenty Years at Sea, or Leaves from My Old Logbooks* (Cambridge, MA: Houghton, Mifflin and Co., 1893), 255, quoted in United States Army Corps of Engineers, Memphis District, *Cultural Resources Investigations and Assessment of the Mound City Shipyard and Marine Ways (11 PU 140), Pulaski County, Illinois* Final Report, October 17, 1986 (New Orleans: R. Christopher Goodwin and Associates, Inc., 1986), 57.

[12]John F. Dillon, "The Role of Riverine Warfare in the Civil War," *Naval War College Review*, March-April 1973, 65-66.

[13]Raphael Semmes, *Memoirs of Service Afloat During the War Between the States* (Baltimore: Kelly, Piet and Company, 1869), 797-798, quoted in United States Army Corps of Engineers, Memphis District, *Cultural Resources Investigations and Assessment of the Mound City Shipyard and Marine Ways (11 PU 140), Pulaski County, Illinois* Final Report, October 17, 1986 (New Orleans: R. Christopher Goodwin and Associates, Inc., 1986), 68.

[14]Office of Naval Records and Library, *Official Records of the Union Navy in the War of the Rebellion,* vol. 23 (Washington, DC: Government, 1894-1922), 79, quoted in Donald L. Canney, *The Old Steam Navy*, vol. 1, *The Ironclads, 1842-1885* (Annapolis: Naval Institute Press, 1993), 38.

[15]James B. Eads, "Recollections of Foote and the Gunboats," *Battles and Leaders of the Civil War*, vol. 1, *Century Magazine* (New York: 1887), 339-340, quoted in Donald L. Canney, *The Old Steam Navy*, vol. 1, *The Ironclads, 1842-1885* (Annapolis: Naval Institute Press, 1993), 38.

[16]*Official Records of the Union and Confederate Navies in the War of the Rebellion,* vol. 23, 215.

[17] Canney, *The Old Steam Navy*, 45.

[18]The Battle of Hampton Roads, the so called first battle between ironclad vessels occurred in early March of 1862, one month after Captain Foote's city-class ironclads fought in the battles for Forts Henry and Donelson

.

Chapter 3

[1]Henry Walke, *Scenes and Reminiscences of the Civil War in the United States, on the Southern and Western Waters*, (New York: F. R. Reed & Company, 1877), 26.

[2]Ibid., 25-27.

[3]Ibid., 27-28.

[4]Mark M. Boatner III, *The Civil War Dictionary* (New York: Vintage Books, 1988), 119-121.

[5]Frank M. Bennett, *The Steam Navy of the United States* (Westport, CT: Greenwood Press, 1896), 264-268.

[6]Edwin C, Bearss, *Hardluck Ironclad, The Sinking and Salvage of the Cairo* (Baton Rouge: Louisiana State University Press, 1980), 25.

[7]Walke, *Scenes and Reminiscences of the Civil War in the United States, on Southern and Western Waters*, 31.

[8]Ibid., 34.

[9]Ibid., 41.

[10]Ibid., 41-42.

[11]Ibid., 36.

[12]Fletcher Pratt, *Civil War on Western Waters* (New York: Henry Holt and Company, 1956), 53.

[13]Eugene B. Canfield, *Notes on Naval Ordnance of the American Civil War 1861-1865* (Washington, DC: The American Ordnance Association, 1960), Chapter 1.

[14]Walke, *Scenes and Reminiscences of the Civil War in the United States, on Southern and Western Waters*, 54.

[15]Ibid., 55.

[16]Musicant, *Divided Waters*, 194-195.

[17]In the naval parlance of the era, maneuverability referred to speed and the ability of a vessel to accelerate as well as the ability to turn in an expeditious manner.

[18]Walke, *Scenes and Reminiscences of the Civil War in the United States, on Southern and Western Waters*, 65-66.

[19]Ibid., 63.

[20]Ibid., 62.

[21]Ibid., 66.

[22]Musicant, *Divided Waters*, 198.

[23]Ibid., 199.

[24]Pratt, *Civil War on Western Waters*, 59.

[25]Canney, *The Old Steam Navy*, 51.

[26]Walke, *Scenes and Reminiscences of the United States Civil War, on the Southern and Western Waters*, 86.

[27]A primitive heat exchanger used to preheat feed water prior to its introduction into the boiler's firetubes.

[28]Musicant, *Divided Waters*, 200.

[29]Ibid., 200.

[30]Canney, *The Old Steam Navy*, 53-54.

[31]Walke, *Scenes and Reminiscences of the United States Civil War, on the Southern and Western Waters*, 84.

[32]Jack D. Coombe, *Thunder Along the Mississippi* (New York: Sarpedon, 1996), 49.

[33]The USS *Cairo* sunk within 12 minutes of being holed below the waterline by a torpedo.

[34]Canfield, *Notes on Naval Ordnance of the American Civil War 1861-1865*, 5-6.

[35]David Dixon Porter, *Naval History of the Civil War* (New York: The Sherman Publishing Company, 1886), 135, quoted in United States Army Corps of Engineers, Memphis District, *Cultural Resources Investigations and Assessment of the Mound City Shipyard and Marine Ways (11 PU 140), Pulaski County, Illinois* Final Report, October 17, 1986 (New Orleans: R. Christopher Goodwin and Associates, Inc., 1986), 89.

[36]United States Army Corps of Engineers, Memphis District, *Cultural Resources Investigations and Assessment of the Mound City Shipyard and Marine Ways (11 PU 140), Pulaski County, Illinois* Final Report, October 17, 1986 (New Orleans: R. Christopher Goodwin and Associates, Inc., 1986), 54.

[37]Ibid., 136.

[38]Ibid., 49.

[39]Robert M. Hurst Jr., "Marine Ways at Mound City Played an Important Part in the History of this Nation," *Cairo Evening Citizen*, (Cairo, IL), 2 November 1938, quoted in United States Army Corps of Engineers, Memphis District, *Cultural Resources Investigations and Assessment of the Mound City Shipyard and Marine Ways (11 PU 140), Pulaski County, Illinois* Final Report, October 17, 1986 (New Orleans: R. Christopher Goodwin and Associates, Inc., 1986), 83.

[40]These vessels were still under construction or completing outfit and final adjustments and did not participate in the battles at Henry and Donelson.

[41]Edwin C, Bearss, *Hardluck Ironclad, The Sinking and Salvage of the Cairo*, 190.

[42]Tom McGrath and Doug Ashley, *Historic Structure Report, USS Cairo* (Denver: U.S Department of the Interior, National Park Service,1981), 144.

[43]River islands frequently appeared and disappeared with the shifting channel. As such, they were often named for their location relative to some reasonably fixed landmark. Island No. 10 was the 10th island downstream from the confluence of the Ohio and Mississippi Rivers.

[44]Coombe, *Thunder Along the Mississippi*, 85-98.

[45]Walke, *Scenes and Reminiscences of the United States Civil War, on Southern and Western Waters*, 124.

[46]Coombe, *Thunder Along the Mississippi*, 91-93.

[47]Tom McGrath and Doug Ashley, *Historic Structure Report, USS Cairo* (Denver: U.S Department of the Interior, National Park Service,1981), 39, quoted in Donald L. Canney, *The Old Steam Navy*, vol. 1, *The Ironclads, 1842-1885* (Annapolis: Naval Institute Press, 1993), 52.

[48]Canney, *The Old Steam Navy*, 52.

[49]The account of the action at Plum Point Bend is described by numerous sources. The author used the descriptions of Boynton, Pratt and Musicant as references in recounting the battle.

Chapter 4

[1]Canney, *The Old Steam Navy*, 95.

[2]Ibid.

[3]Ibid.

[4]Ibid., 96.

[5]Ibid., 95-97.

[6]*Official Records of the Union and Confederate Navies in the War of the Rebellion*, vol. 23, 449.

[7]Musicant, *Divided Waters*, 268, 270-271.

[8]*Official Records of the Union and Confederate Navies in the War of the Rebellion*, vol. 24, 246.

[9]Ibid., 248.

[10]Ibid., 276.

[11]Ibid., 277.

[12]Ibid., 281.

[13]Ibid., 282.

[14]Canney, *The Old Steam Navy*, 98-99.

[15]*Official Records of the Union and Confederate Navies in the War of the Rebellion*, vol. 24, 659.

[16]Ibid.

[17]Canney, *The Old Steam Navy*, 99.

[18]*Official Records of the Union and Confederate Navies in the War of the Rebellion*, vol. 24, 659.

[19]Ibid.

[20]Pratt, *Civil War on Western Waters*, 149-150.

[21]Canney, *The Old Steam Navy*, 101-102.

[22]Walke, *Scenes and Reminiscences of the United States Civil War on Southern and Western Waters,* 386.

[23]Bestor was a contractor based in Peoria, IL. The vessel, the USS *Ozark*, was built in Mound City.

[24]Canney, *The Old Steam Navy*, 107.

[25]Ibid., 110.

[26]Ibid., 110-111.

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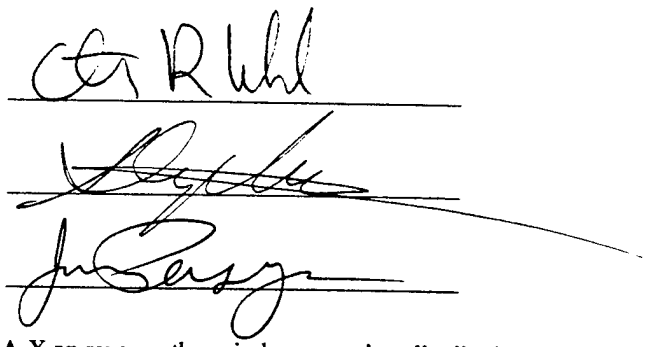

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